# POWER

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## Perseverance

MANY a promising future has faded into gray insignificance, many a man of genius and talent has turned out a failure, many a brilliant project has drifted upon the flats, because of the lack of perseverance.

A man may have a good project and a good opportunity to develop it. He may have the means and tools, mental and otherwise, to carry it through; but unless he has that quality that has been inelegantly called "guts," he will wind up in a weed-bed of excuses.

Few tasks are accomplished without hindrance, and most achievements of any value have been arrived at through courses beset with difficulty and discouragement.

It is not the man with a plausible alibi, with a good excuse as to why he did not succeed, who brings home the bacon. It is the man who finds the reason that is behind the difficulty and overcomes it, the man who can find the way around an immovable obstruction, the man who accepts each set-back as a challenge and can come up smiling repeatedly, ready to try again, who enjoys the honors and rewards of success.

Progress will perhaps be slow, employers or fellows in interest may be impatient and critical, promising prospects may turn out to be illusive, rival interests and envious associates will furnish lots of discouragement and wet blankets, especially if you appear to be getting on.

There will be times when the game seems not to be worth the candle, when interest flags and allurements entice.

The man who has the stamina to keep on putting the best that there is in him into the job, with a persistency that grows more dogged the more obstinate and grueling the task becomes, with his eye on the goal and his interest set on getting there, is bound to succeed, if not in one thing, in another.

F. R. Low

# Reciprocating Engine Uses Steam at 686 Degrees

## Cross-Compound Non-Condensing Poppet-Valve-Corliss Combination, Designed for 350 Lb. Pressure and 250 Deg. of Superheat

AT THE plant of the Dow Chemical Company at Midland, Mich., the power demand is heavy and practically constant, and with large uses for exhaust steam for process work such as the evaporation of salt brine, which forms the base of various products made by the company, the conditions are ideal for the high operating economy always obtainable when it is possible to balance the power and process steam. With this end in view a highly efficient prime mover was desired, one that would operate non-condensing at a back pressure of 3½ to 5 lb. and still produce the maximum amount of power from the steam supply. To company engineers who had made a careful study, it was apparent that the prime mover should be a reciprocating engine using steam at the highest final temperature that would be feasible under practical operating limitations. The decision was made to supply steam to the throttle at 350 lb. gage pressure and superheated 250 deg. F. to give a final steam temperature of 686 deg. The generating capacity was to be 1,000 kw.

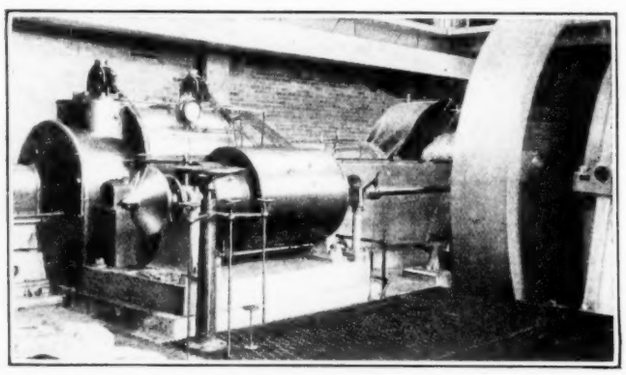

*Fig. 1—High-pressure side of engine in service*

It was evident that a special design was required for the service and the Nordberg Manufacturing Co was called upon to supply the new engine.

### Selecting the Type of Engine

Starting with these unusually severe steam conditions for any prime mover, the problem was to design an engine that would be thoroughly reliable, be simple in construction and at the same time give the highest economy. For a steam temperature in the vicinity of 686 deg. F., a Corliss cylinder for the high-pressure end could not be considered. When operated non-condensing, a uniflow engine does not give its highest economy. A triple-expansion engine was considered too complicated and expensive. So it was decided that a cross-compound unit would best meet the conditions, using a poppet-valve cylinder to take the initial steam and a Corliss cylinder for the low-pressure side, a combination that had often been used with good success by the company.

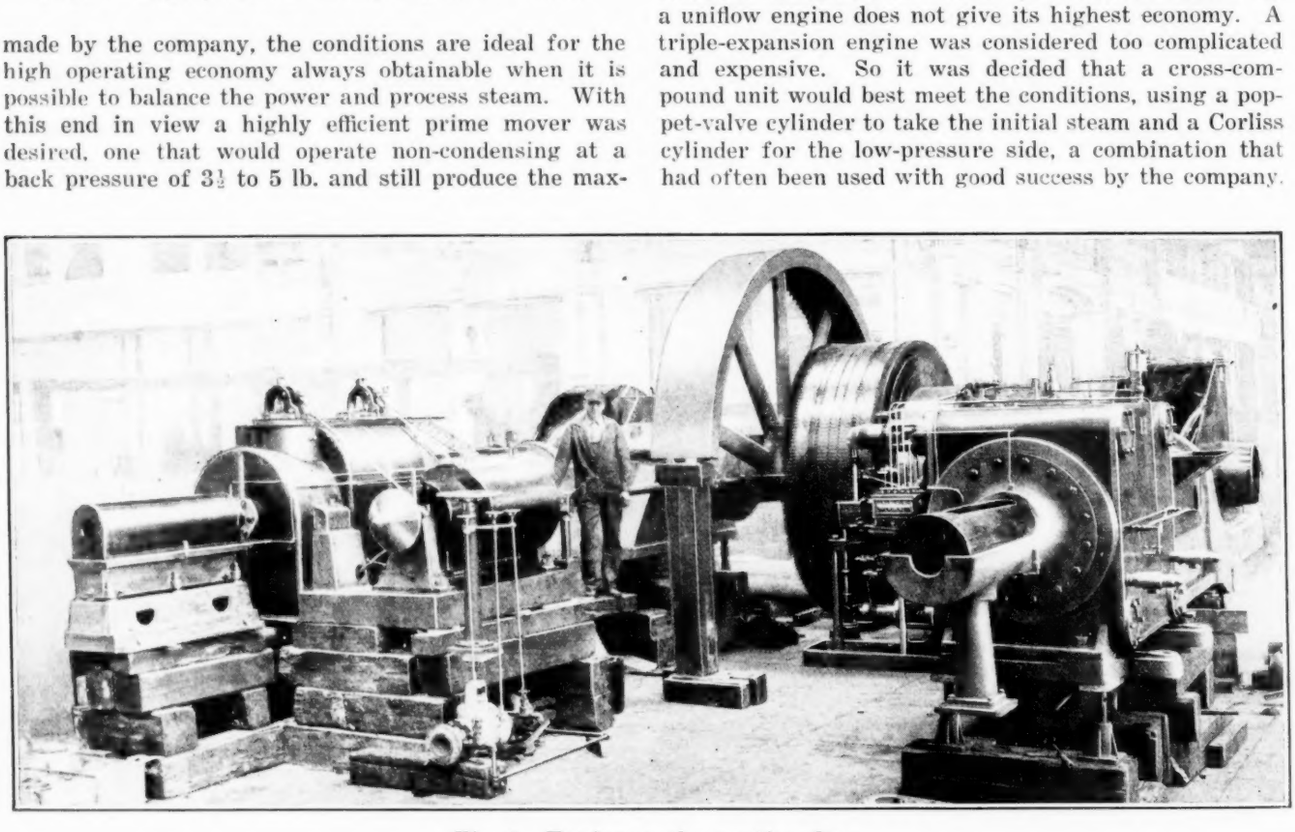

*Fig. 2—Engine on the erecting floor*

In the design of the high-pressure side a number of entirely practical features uncommon in engine practice were introduced to guard against heat loss from the cylinder, expansion strains and distortion. Although of standard design, the valves and valve gear were made heavier and stronger to withstand the service. The high-pressure cylinder heads were steam-jacketed and a special insulating covering provided for the cylinder barrel, as experience had shown that steam-jacketing of the barrel would show no material gain. Between the cylinders was provided a receiver of the reheating tubular type using live steam from the main high-pressure supply line with a control valve located near the main throttle valve. From the main supply and similarly controlled is a second line to supply live steam,

PRINCIPAL DIMENSIONS OF ENGINE UNIT

| | |
|---|---|
| Cylinder diameter, h.p., in. | 17 |
| Stroke, in. | 30 |
| Cylinder diameter, l. p., in. | 32 |
| Stroke, in. | 40 |
| Ratio of cylinder volumes | 1 to 4.95 |
| Speed, r.p.m. | 120 |
| Piston speed, h.p., ft. per min. | 600 |
| Piston speed, l. p., ft. per min. | 800 |
| Steam pressure, lb. gage | 350 |
| Superheat, deg. F. | 250 |
| Steam temperature, deg. F. | 686 |
| Back pressure, lb. gage | 0 to 5 |
| Estimated steam consumption at 0 back press., lb. per i. hp.-hr. | 11.25 |
| Main bearings, diameter, in. | 13.75 |
| Main bearings, length, in. | 27 |
| Crankpins, diameter, in. | 7 |
| Crankpins, length, in. | 6.75 |
| Crosshead pins, diameter, in. | 5.5 |
| Crosshead pins, length, in. | 8 |
| Crosshead shoes, width, in. | 12 |
| Crosshead shoes, length, in. | 20 |
| Piston rod h.p., diameter, in. | 5 |
| Piston rod l.p. diameter, in. | 5.5 |
| Belt wheel, diameter, ft. | 15 |
| Belt wheel, face, in. | 22 |
| Belt wheel, weight, lb. | 23,000 |
| Generator: | |
| Make | Crocker-Wheeler Company |
| Type | Interpole, shunt wound, direct current |
| Capacity, kw. | 1,000 |
| Voltage | 250 |
| Speed, r.p.m. | 120 |

reduced to 75 lb. pressure, to the receiver for starting the unit on the low-pressure side, if necessary.

As indicated in Fig. 2, a shop view of the unit, and the plan and elevation, Fig. 3, the engine is a horizontal cross-compound machine directly connected to a 1,000-kw. shunt-wound, direct-current generator having a speed of 120 r.p.m. At full load, atmospheric exhaust and the steam conditions previously given, the steam consumption was estimated at 11¼ lb. per indicated horsepower-hour.

Cylinder sizes of 17x30 in. for the high-pressure end and 32x40 in. for the low-pressure were adopted. These dimensions, coupled with a speed of 120 r.p.m., gave piston speeds of 600 and 800 ft. per min., respectively. Notice will be taken of the variation in stroke between the two cylinders, this being due to a requirement of the purchaser that the high-pressure piston speed should not exceed 600 ft. per min., owing to a desire to avoid possible lubricating troubles that might develop if this piston velocity were exceeded. Cylinder volumes bear a ratio of 1 to 4.95. Other dimensions of the principal engine parts are included in the accompanying table.

One of the conditions imposed by the high steam temperature was special flexibility of the supply piping. How this is provided is shown in Fig. 3. Steam enters a receiver separator under the floor, passes through the throttle valve and a long radius turn to a special Y piece connecting through long drop elbows with each valve chest. It will be seen that this arrangement will permit longitudinal expansion of the cylinder and of the piping without setting up undue strains.

As previously intimated, the high-pressure cylinder has been designed to prevent heat loss through conduction to other parts of the engine. It is secured to the bedplate by four supporting feet, one at each corner, so shaped as to give minimum contact. The bottom of

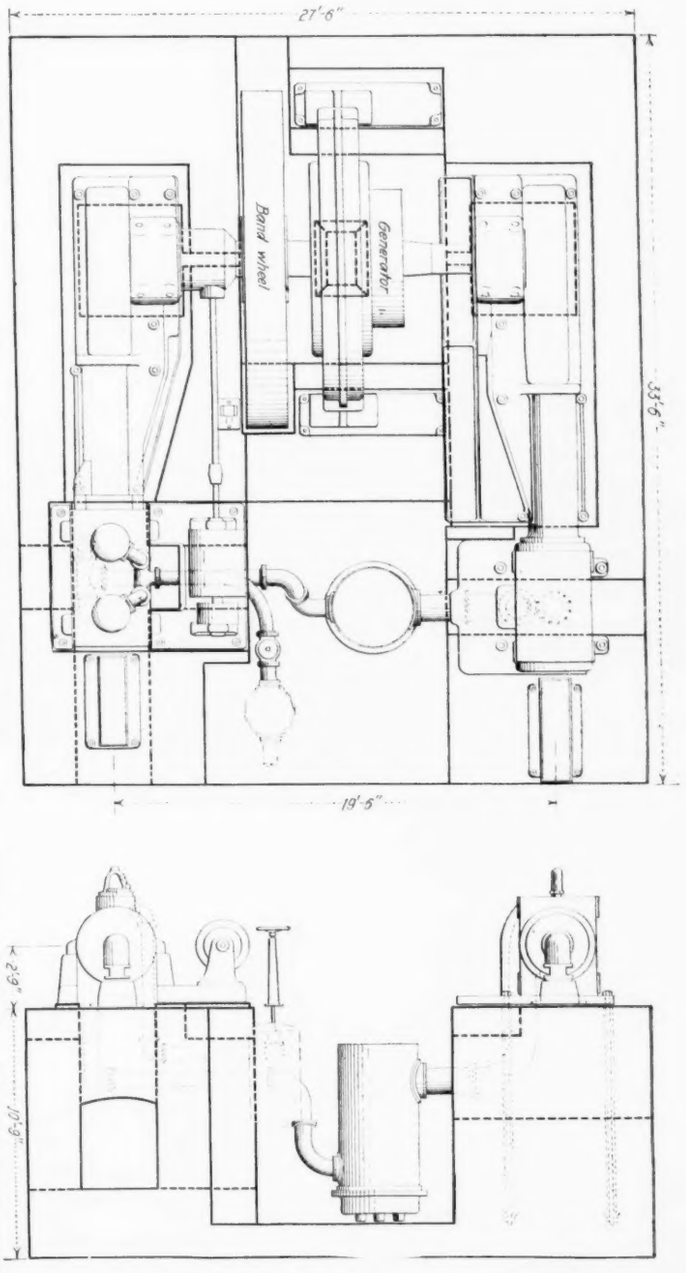


*Fig. 3—Plan and elevation of engine unit*

these feet are only 4 in. below the center line of the cylinder, so that the latter is free to expand in either direction without disturbing the alignment.

Contact with the frame is minimized by the use of distance pieces 13 in. long, which are lined up with large bosses at the side of the cylinder and the frame, so that tie bolts may be used to hold together the two engine parts. These bosses and the supporting feet are shown plainly in Fig. 4. There are 1-in. dowels at the

bottom of the supporting feet to prevent side movement of the cylinder.

For the foregoing reasons, separation of the cylinder from the tail guide also was desired. As efficient lubrication was desirable and special pains had to be taken to keep the oil out of the exhaust, both cylinders were equipped with floating pistons. Instead of adopting the usual method of bolting the tail guide to the cylinder head, the guide for the high-pressure piston was separated entirely from the cylinder. It was made up of a box-section bedplate to which the guide is secured by a special pivot bolt, so that it may be turned aside to permit withdrawal of the cylinder head and piston. The guide is equipped for setscrew adjustment vertically and horizontally to maintain exact alignment. The construction is shown plainly in Fig. 1, and although there was no occasion for this design on the low-pressure cylinder, the usual type of guide shown in the photograph was replaced later by the new design for the sake of uniformity.

The high-pressure cylinder is equipped with four double-beat poppet valves of the balanced type, seating in separate removable cages, so that distortion of the cylinder casting may not interfere with the tightness of the valve. As is customary, the two inlet valves are at the top of the cylinder and the exhaust valves below. The inlet valve gear is of the non-releasing type, the

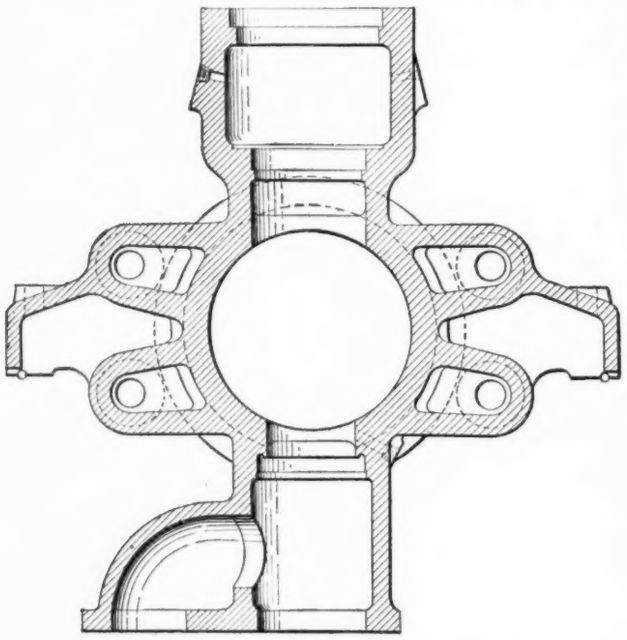

*Fig. 4—Transverse section through high-pressure cylinder*

valves being opened and closed by cams operated from eccentrics on the layshaft. Separate eccentrics operate each exhaust valve direct from the layshaft. To take care of the forces due to the high-steam pressure, special reinforcing bolts of chrome nickel steel are introduced in the ribs of the valve cages. Fig. 6 shows the steam valve gear assembly.

The governor, which is located between the eccentrics on the layshaft, is of the centrifugal and inertia type, controlling the cutoff of the steam valves by varying the effective throw of the steam eccentrics. The engine is provided with a speed-changing device by means of which the speed can be regulated at will from one-half to full speed. This is effected by means of a handwheel at the end of the layshaft, which carries around with it a threaded rod functioning in connection with a bell crank and lever to vary the tension of the governor springs. This variable-speed governing mechanism is of no immediate benefit in the present use of the engine where constant speed is required. It was provided, however, as the engine eventually had been intended for another plant where a speed range of from 60 to

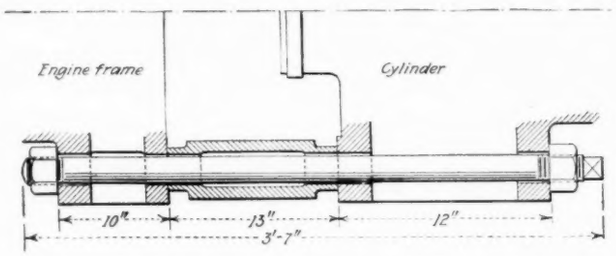


*Fig. 5—Distance piece between cylinder and frame*

120 r.p.m. was desired. The low-pressure side has a cutoff adjustable by hand, and in addition is equipped with an overspeed device which, in case of overspeeding, holds the trip steels of the steam-valve operating mechanism out of contact and thus prevents steam from entering the cylinder. The control for this device is on the high-pressure layshaft with cable connection to the low-pressure valve gear.

In the oiling system there are a number of features that may be of interest. The usual automatic system carries oil to all principal bearings, the overflow being collected, filtered and pumped to an overhead supply tank, from which the oil flows back by gravity to the engine under a head of 15 pounds.

### Lubrication of Piston Rings

Owing to the high temperatures it was particularly desirable that the piston rings on the high-pressure piston be properly lubricated. Oil is introduced around the center of the cylinder at points spaced 90 deg. apart. These four supply ports have been introduced in addition to the regular feeds—that is, one in each steam valve chest above the poppet valves and one in each piston-rod packing case—so that the high-pressure cylinder has eight feeds from the lubricating pump, which is of the plunger type with eight adjustments and driven from the layshaft by an eccentric.

On the high-pressure side the exhaust poppet-valve gear runs in oil. On the low-pressure side the oilers for the carrier arms are stationary, the lubrication being effected by installing nickel-plated oil boats on the tops of the carrier arms. From these boats the oil is supplied to all lubricated surfaces at this point.

To lubricate the crosshead pins, a new plan has been devised to supplant the usual telescopic oiler or wiper. Oil from the general system is supplied above the engine frame and feeds by gravity through a $\frac{3}{8}$-in. hole in the top crosshead slide. The top shoe is recessed so that some portion of the slot will be under the hole in the slide at any point of the stroke. The oil accumulates in the slot and flows down through a hole in the crosshead shoe to an oil boat on top of the connecting rod, which has drilled connection with the crosshead pin. This arrangement is direct and simple and eliminates the

difficulties often experienced with the telescoping type of oiler.

At this writing the official tests on the engine have not been made, but it may be of interest to know that the engine has been in continuous, non-stop service

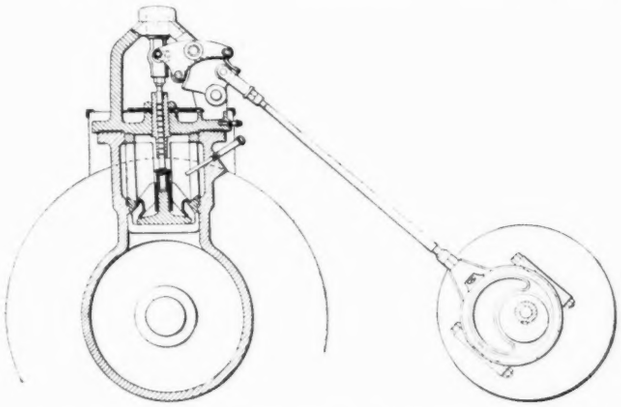

*Fig. 6—High-pressure steam valve gear assembly*

since Feb. 19, operating under a steam pressure of 380 lb. and a temperature of about 640 deg. F., which indicates an increase of 30 lb. in pressure over contract requirements, although the superheat has been below the 250 deg. F. specified. According to reports from George H. Wallace, who has been in charge of the erection of the engine, the performance has been altogether satisfactory, so that the installation would appear to be an excellent example of the application of the reciprocating steam engine to high steam pressures and temperatures.

# Record-Breaking Steam Temperatures at Gennevilliers

By R. H. Andrews
Paris Correspondent of *Power*

GENERATING unit No. 6 of the Gennevilliers central station of the City of Paris has probably set a world's record in commercial service under high steam temperatures. The accompanying table gives the summary of this service over a period of about two and one-half months, from October to December, 1925, inclusive.

TOTAL HOURS OF SERVICE OF UNIT NO. 6 ABOVE GIVEN TOTAL TEMPERATURES AT THE THROTTLE

| | |
|---|---|
| 580 hours above | 705 deg. F. (Standard at full load) |
| 400 hours above | 725 deg. F. |
| 240 hours above | 750 deg. F. |
| 135 hours above | 775 deg. F. |
| 75 hours above | 800 deg. F. |
| 44 hours above | 820 deg. F. |
| 22 hours above | 840 deg. F. |
| 8 hours above | 860 deg. F. |
| 5 hours above | 880 deg. F. |
| 2 hours between | 900 and 914 deg. F. |

The turbine was designed for a throttle pressure of 318 lb. and a total temperature of 705 deg. F. (280 deg. superheat). During the period covered by these observations it had operated a total of 580 hours between its normal throttle temperature and the impressive peak of 914 deg. F.

The turbine was opened up on Dec. 25, 1925, and subjected to a minute examination in order to detect any deterioration that might be charged to the steam temperatures. All the parts exposed to these temperatures were, however, found to show no signs of injury. The unit has been put back into service and has since then totaled more hours of service than any of the other five units, in spite of the exceptionally high temperatures to which it is still subjected almost daily.

It is unusual to find a number of generating units in a central station exposed to such a divergence of steam conditions. The explanation lies in the difference between the characteristics of the original Stirling and B & W boilers and the new powdered-coal fired units put into service for the first time in October, 1925. The four 19,750-sq.ft. boilers composing the new plant were designed to give a minimum total steam temperature of 750 deg. F. with 5,200-sq.ft. superheaters. Owing to heavy overloads imposed during the tests, this temperature was far exceeded, as were those produced by the old boiler plant. It so happens that the new plant feeds into the station mains at points much nearer the take-off for Unit No. 6 than those of the other units, so that No. 6 draws nearly all the hotter steam. It still remains, however, the "star" generating unit of the station, and carries a heavier schedule, both in average loads and in hours of service, than any of the other five units. The turbine and generator were both built by the "Société Alsacienne de Construction Mécaniques."

The powdered-coal-fired boilers of the new plant are of the Ladd water-tube type and were supplied by the "Société Delaunay-Belleville," licensees for France. The fact that the superheaters were able to stand such temperatures is of decided interest.

During the observations the throttle temperatures were measured by means of mercury thermometers, the pocket being in the main just before the throttle. The thermometer readings were checked against those of a Leeds & Northrup pyrometer, which was calibrated at the beginning and the end of the test period by observing the melting point of zinc, which is close to the center of gravity of the temperatures measured. It is probable that the latter were accurate to within less than 5 deg. F.

The importance of this experiment for future developments in generating equipment can hardly be overestimated.

The writer is indebted to A. Rauber, superintendent of the Gennevilliers central station, for the foregoing material.

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A Rule Widely Used in Great Britain for choosing the capacity of a vacuum pump for a surface condenser is as follows:

$$[Lb.\ of\ air\ per\ hour] = 3 + \frac{[lb.\ of\ steam\ per\ hour]}{2{,}000}$$

While this rule of course cannot apply to all conditions, it is sufficiently close for practical design purposes. Installations naturally vary widely in leakage and in the amount of air accompanying the steam from the turbine exhaust, so that any calculated results of this sort are simply expressions for determining the capacity of vacuum pump which has proved satisfactorily adequate in previous installations. High precision in such computations is unnecessary and inappropriate.

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The theoretical maximum head in feet against which a centrifugal pump can deliver water is equal to the square of the rim velocity of the impeller (in feet per second) divided by 64.4. This is the same as the theoretical height to which a ball or projectile would rise if thrown vertically upward with the given velocity.

## *Don't Underestimate the*

# Plant Labor Problem

### Chief of Long Experience Says Understanding of Men Is Master Key to Efficient Operation

HANDLING labor has not, is not and cannot be done on a scientific basis. What goes with one man will not go with another. For instance, praise one man and he will try to do better. Another one can't stand praising; tell him he did a good job and he gets a swelled head or wants a raise. Talk decently to one man and he will respond in like manner; talk the same way to another and he will think you are afraid of him.

I am glad to say that these negative cases are in the minority, but they are common enough to prove that handling labor cannot be done on a cut and dried basis and that every man should be dealt with according to his characteristics. No two of us are alike in every respect. What suits one would not suit another. What one man can do another one cannot do. Some are willing, others unwilling; some strong, others weak; some want to learn, others don't care a hoot whether they learn or not. It is all these traits and characteristics that men have, that the man who has charge of men must learn before he can handle labor with any degree of success. Besides knowing the traits and characteristics of different individuals, you must have certain qualifications and traits if you expect to steer your men through the pitfalls that beset every job and every man every day.

**This is a human treatment of a human problem. The writer has been through the mill—he is chief engineer of a large station. Speaking solely from first-hand knowledge, he outlines the essential characteristics of a loyal and effective power-plant organization, and points out the pitfalls that may bring disaster to the unwary chief. Here is a chance to profit by another man's experience.**

The greatest asset you can have in handling labor is good common sense; without it you are bound to strike all kinds of snags and be in hot water most of the time.

If you want to avoid the shoals, be *fair* in all your dealings with the men; you can't make flesh of one and fowl of another and get away with it for very long. If you don't play fair and give everyone a square deal, you can be mighty sure that the men won't give you or the company a square deal.

You must give the company a square deal also, and see that the men do the same—and most of them will, if you and the foremen under you give them a fair shake. It's up to you to see that the foremen are on the level and play the game fair with the men under their charge. A foreman that does not do this can stir up a lot of discord and get himself into trouble with the men. In these disputes you must take the part of the foreman, but when it is all over you can take that foreman aside and read the riot act to him in such a manner that he will walk the straight and narrow path in the future. If there are many cases of this kind, it is a good scheme to demote the foreman until he has learned his lesson, or take such other action as you think will work to the best interest of all concerned. A great deal of the trouble between the company and the men has been caused by foremen who are not fair, and too short-sighted to shoot straight.

Playing favorites is another source of trouble that is easily avoided by not doing it. If you do for one and don't do for another you will be criticized.

A power station can no more be operated without discipline than can an army. You need not be so strict as in the army, but you must have discipline enough so that each man will do as he is told without any question—and, what is almost as important, do it willingly.

In making rules to govern all the employees, make as few as possible. Make them plain and simple, so that they will be intelligible to the foreigners as well as the rest, but have enough to cover all general violations that are likely to crop up from time to time. The habit of coming in late habitually is particularly objectionable. A few other general rules are all that is necessary, but the ones made must be enforced or they might better not have been made. When a man has a complaint to make, have him take it up with the foreman, and not run to you; it is time enough for you to straighten it out when the foreman can't. It is good policy to have the foreman present at these hearings. Sometimes the man is not satisfied with your ruling and takes it to headquarters; if he does this, you should be in on the hearing as well as the foreman. In all trouble of this kind—and you are bound to have it more or less—the cause should be sought and removed if possible. Complete justice should be the essence of the decision.

Every man should know his post in case of emergency and be there knowing just what to do in the quickest possible time without losing his head. The men must understand that you are the head of the plant and are responsible for its safe and economical operation twenty-four hours a day, every day in the year; that continuity of service is more important than economy and must be the first consideration in all emergencies; that your orders must be carried out to the letter.

If your orders are wrong, you are the goat and should

take the responsibility; don't try that great American indoor sport of passing the buck; take your medicine like a good soldier and do better next time. If you try to pass the buck, you will stir up future trouble and lose the respect of the men.

In maintaining discipline you must have system—call it red tape if you will—but if things are not done in a systematic manner you cannot maintain discipline. All orders that you wish to give the men should be given through the foremen and enforced and carried out by them. If any of these orders are not carried out as you intended, find out why, whether it is the fault of the men or the foreman; I'll wager eight times out of ten it will be the fault of the foreman, who has opinions of his own and thinks his own the best. Sometimes foremen get the orders twisted; if the orders are written out there can be no such mistakes.

If the foremen will not do what you tell them, you surely can't expect the men to, and it does not take many of these instances before your discipline is shot full of holes. The best time to stop these infractions is the first time you discover them. Nip them in the bud, and you will not have to do that many times before everyone will know that you mean business, but if you wink at these violations, it will not be long before you will have to overlook bigger things.

In reprimanding any one for something he has done or not done, it is not necessary to tear his hide off to let him know that you mean business, nor is it necessary to make a big noise and let the whole force know that Mike or Tom has murdered someone and you are giving him hell for it. Do it in a quiet dignified manner and it won't leave a bad taste in the mouth of Tom or Mike, but will sink in and do much more good than the big noise.

If a quiet talk won't meet the situation, have the man come to the office where you can trim him to your heart's content without anyone being the wiser. The less of this kind of stuff you do, the better; if you have the right kind of organization and handle it properly, you will not have to do it very often; the great majority of men want to do what is right and will, if given a fair shake themselves.

**You can be good natured without being an easy mark. It is good policy always to speak to the men as though they were men.———But don't get too chummy!**

Drop into the plant once in a while in the evening or night to see what is going on, and that everyone is where he belongs and doing what he is supposed to be doing, and have the foremen do the same thing occasionally for the same purpose. I do not mean that you should do any old sleuth stunt, or gum-shoe act. Just walk in the front door as usual; the mere fact that someone is likely to drop in after regular hours will have the desired effect.

When you get up in the morning with a bad taste in your mouth, or the wife has given you the customary setting up exercise, don't go down to the job and take it out on the men. The world looks dark and dreary under these conditions, and you are likely to say more than you intended, so it is better to stay in the office until the sun begins to shine, unless you are looking for trouble. If you are, go out in the plant. You will probably find some one else with the same complaint, in which case you can start trouble enough to last some time and maybe longer.

A good disposition is a wonderful asset; the man who has such a temperament is a lucky dog and will have much better results in handling labor than the fellow with a habitual grouch, or one that flies off the handle at the slightest provocation. You can be good natured without being an easy mark. Not one man in a hundred will take advantage of your good nature unless he is a chump and does not know that you can trim him to the queen's taste when occasion requires such treatment. It is good policy always to speak to the men as though they were men, and not as you would to a wild bull. They are human even as you and I, and like to be treated accordingly. Their blood may not be as blue as yours, but it is just as red, and that is what counts.

**All of us are overgrown boys and like to do more or less fooling, but a power station is no place for horseplay. If it is allowed there will be trouble sooner or later.**

A cheery good morning, or "hello, Bill," when you pass a man always counts for a better feeling. It helps over the rough spots and does you no harm; the better feeling you have on the job the better for you and the entire force and plant. But don't get too chummy; that is another matter and may get you into hot water.

All of us are overgrown boys and like to do more or less fooling, but a power station is no place for horse play. If it is allowed to go on, there will be trouble sooner or later. I have seen some very serious accidents that were caused or brought on by fooling, also a number of bitter quarrels that lasted as long as the men mixed up in it were in the station. In one case I know of it nearly disrupted the whole organization, so that several men had to be discharged before it was straightened out—and it all started over a silly thing that did not amount to a hill of beans. Every well-regulated power station should have a thoroughly modern first-aid room with the necessary equipment for treating all kinds of accidents, whether of a minor or major kind. Several of the men should be well drilled in first aid and know how to treat minor injuries and how to take care of the more serious ones until a physician arrives. First aid pays the company bigger dividends than it does the men; you are treating the man from a humanitarian standpoint, but the company is the one that gains by not losing the services of a trained employee, and by the better feeling the man has because the company looked after his injury.

If it is necessary to take the man home or to the hospital, send some one along to see that he is properly taken care of and that his family is looked after during the time that he is laid up. Go slow about calling on these cases yourself; if you call on Tony and Bill and don't call on Joe, Joe is likely to feel slighted; if you try to call on all of them you may be a busy man; it is better to delegate this work to someone else.

Instruction in resuscitation is fully as important as first aid and should be taught all the men; they should be drilled in it often enough to make certain that they know how to do it properly.

A good restaurant or lunchroom is an adjunct that pays—a place where the men can get a clean, wholesome meal at a moderate price. This is especially advantageous where the plant is located in an out-of-the-way place, or in a bum neighborhood where the hash houses or beaneries are of the wrong kind.

A cooling system for the drinking water is as necessary as most other improvements that are installed in modern stations, and should be included. Large, roomy toilet rooms, equipped with roomy lockers spell contentment in a small way but are along the right line. All these things help.

**Wherever possible promotions should be made from the rank and file. If you have to go outside let the men know why. It is their own fault if they were asleep at the switch.**

When you make a promise you have every intention of keeping it, but what you promise today may be impossible to carry out tomorrow, for reasons of your own, or reasons over which you have no control. If you don't want to break a promise, don't make any, and stick to it as long as you are in the game. When you have your own yacht and country estate, you can make 'em if you want to, but by that time you will be too wise to make promises. Seriously, brother, if you want to keep the high regard of the men, never break your word with them if it's humanly possible to keep it.

When you hire a new man, you sometimes believe from the things that he tells you and from the experience he has had or says he has had, that he is the white-haired boy. He may be and again he may not. Keep a good eye on him, and have his foreman do the same. If he makes good, you have a first-class man. If, at the end of two weeks you and the foreman decide that he is a lemon, don't keep him; tell him he does not fill the bill and must look for something else. If you feel charitable, give him a few days to look for another place. You do yourself and the company as well as the rest of the men an injustice when you keep a man that is no good. If there is a man on the job that does not suit and will never make a power-station man, tell him to look for something in another line. Give him a month to hunt something else, if you feel so disposed.

I do not consider letting men go under such circumstances the same thing as discharging them. Where a man is prompt, steady and willing, but does not grasp his job, and is just a steady old plug kind of a fellow, he is in the wrong church as well as the wrong pew. It is a matter of simple kindness to tell him that he does not fit and never will, that he would do much better in some other line of business. You may have to follow up your friendly tip, but not if he has any gumption. I'll bet inside of a year he will thank you for what you have done for him.

But discharging a man is another thing, and should never be done except as a last resort. Try shifting him to another foreman or put him on another watch; there are several things you should try before letting him out.

A good method is to get the foreman's opinion of a man who is under suspicion. If his opinion checks with yours, you know that your judgment is correct and you can act according to your conscience; in other words, let your conscience be your guide. If the foreman's opinion does not check with yours, you may be at fault; try the man somewhere else and check up again.

When it is necessary to promote someone to a higher position, it is not always an easy matter to tell just who is the best man for the new place, especially if you have several to choose from. It is good practice to question the men occasionally about the apparatus they take care of and about other things in the plant and see how well posted they are. If the men know that you are likely to do this, it will have a good effect.

Wherever possible, promotions should be made from the rank and file. It is not much of an incentive to men to do their best if you go outside to get the men for the higher positions, although it is sometimes advisable to do so, and absolutely necessary if you have no one capable of handling a higher or bigger job. In such a case it will not do any harm to let the men know why you went outside; it is their own fault if they were asleep at the switch.

If all your men thoroughly understand that ability is the main factor in being promoted, they will try to learn. You can be a great assistance to them along this line by encouraging them to study not only books but the plant.

A thrift campaign is another paying investment for you as well as the station; get the men interested in saving money or buying a home. Your force will grow steadier as more of the men own their own homes.

Maybe you can get your company interested in an "own your own home" campaign. Try it! The thing is simple enough after the start is once made; in a few years it is all over with, and you have a lot of happy, contented employees.

Along with your other trials and tribulations don't forget our old friend the agitator and trouble maker; his one aim in life is to go about the world and howl calamity and thief and crook at every one that has a better job than he has. If he only turned his energies to some constructive line with the same force that he uses in trying to pull down, he would be a wizard. You may be fortunate and not have any, but it is well to keep your weather eye open for these disturbers. The power industry is the last place in the world where we want any malcontents.

**A thrift campaign is a paying investment for you as well as the station. Get the men interested in saving money or buying a home. Your force will grow steadier as more of the men own their own homes.**

Well, brother, my little spasm is nearly over. No doubt some of you will say, "Why all the detail? Don't we know how to run a power station? Yes, brother some of you do, and I am sorry if I have wasted your time. Some of you old timers may know more about handling men than I ever thought of, but there are a great many men in charge of power plants who do not know much about the labor end. It is to these men that I am trying to give a friendly word of advice. I have not said anything in this article from guesswork or theories. It was all learned in the old school of experience and hard knocks.

# Another Stoker-fired Boiler Shows High Efficiency

By DONALD J. MOSSHART

AN EFFICIENCY ranging from 78 to 84 per cent for a boiler without economizer or air preheater is shown by a series of tests recently conducted at the High Bridge Station of the Northern States Power Co. at St. Paul, Minn.[1]

The plant is equipped with eight Frederick and eight Westinghouse stokers. The tests were conducted on one of the latter units. The boilers are Babcock & Wilcox, 18 tubes high, 42 tubes wide, with 21-ft. tubes, giving 18,772 sq.ft. of heating surface. The boilers are set 16 ft. high, floor line to front headers. Beyond a Foster convection superheater and a Foster radiant superheater, there is no other heat-absorbing surface.

Following studies of operating experience, the stokers have been adjusted to secure rapid ignition of low-volatile coal and to increase the heat absorption by the radiant superheater, so as to yield a nearly constant steam temperature at various boiler loads.

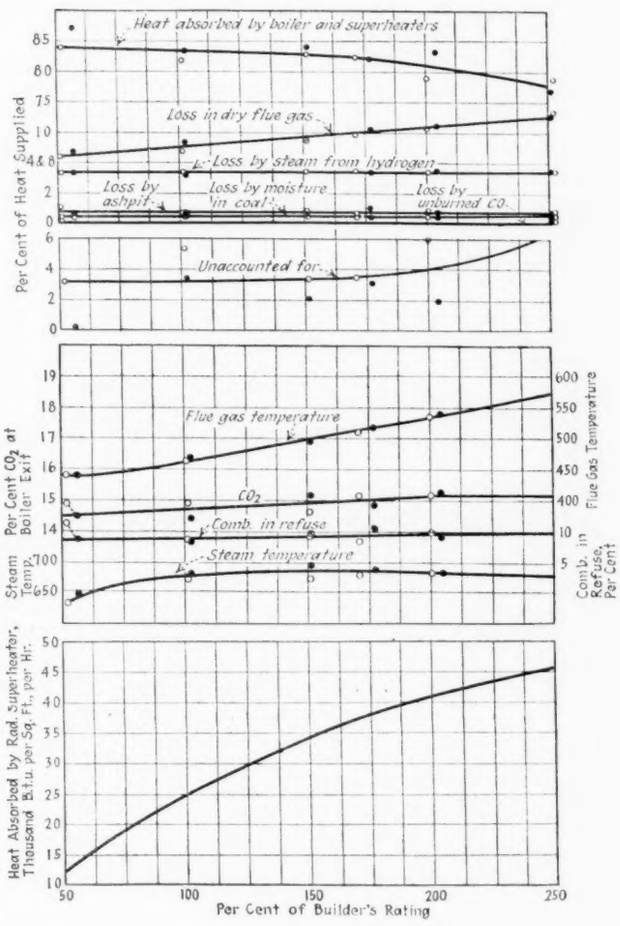
The tests reported here were run after these adjustments had been completed. Every effort was made to reduce errors. The sampling of ashpit refuse lagged sufficiently to allow for the speed of travel through stoker and ashpit, as determined by special tests.

The factor which causes the greatest error in tests of stoker-fired boilers is the difference between the amounts of fuel on the stoker at the beginning and at the end of a test. Even an experienced man cannot estimate the average thickness of the fuel bed on this type of stoker closer than within two inches. If the boiler under discussion were run for 24 hours at 150 per cent rating, about 200,000 lb. of coal would be burned. A layer of fuel 2 in. thick on the stoker would weigh about 3,000 lb. It is evident that if there were 2 in. difference in thickness at the beginning and end of a test, the error in efficiency would be 1.5 per cent.

This error was reduced by conducting the tests in an unbroken series and setting up complete heat balances for the series. The losses otherwise unaccounted for were plotted against boiler load and developed into an average curve, from which the individual test results were adjusted to smooth out discrepancies. This plan distributes errors over the entire series of test runs.

However, in running such a series of tests over a wide range of boiler ratings, another important factor enters. The fuel bed at low ratings is short and thin, and at high ratings is long and thick. Coal must be added to the fuel bed at each successive increase in rating, and burned out of the fuel bed at each decrease in rating. If a series is started at a low rating and ended at a higher one, additional coal is charged against the boiler output at each increase in rating, but this coal does not produce steam until the fire is burned down to the initial thickness. Therefore, a series of tests beginning at low rating and ending at high rating would show for all tests an indicated efficiency lower than the actual. If the series were reversed, the indicated efficiency would be higher than the actual.

The tests covered in this article were run in series,


Heat absorbed by boiler and superheaters
Loss in dry flue gas
Loss by steam from hydrogen
Loss by ashpit
Loss by moisture in coal
Loss by unburned CO
Per Cent of Heat Supplied
Unaccounted for
Flue gas temperature
CO2
Comb. in refuse
Steam temperature
Per Cent CO2 at Boiler Exit
Steam Temp.
Flue Gas Temperature
Comb. in Refuse, Per Cent
Heat Absorbed by Rad. Superheater, Thousand B.t.u. per Sq. Ft. per Hr.
Per Cent of Builder's Rating

*Test results show high efficiency and consistent operation over a wide range of load*

Open circles are for tests with increasing load, solid circles for decreasing load.

Feed temperature averaged 207 deg. F., steam pressure, 300 lb. per sq.in. gage.

the first half of the series at increasing ratings and the second half at decreasing rating. The durations of the tests were fixed to burn as nearly as possible the same amount of the coal on all tests.

The tests throughout demonstrated remarkable smoothness and ease of operation and show consistent performance of high order. They cover a period of 13 days of continuous operation. The results are similar to those obtained from these boiler units as a monthly average, and are gratifying when it is considered that such auxiliaries as air preheaters, water-cooled furnace walls and economizers were absent.

[1]The plant was described in *Power* for Dec. 23, 1924, (page 1006), and a more complete report of the tests is given in *Bulletin of Management* for April, 1926, in an article by Lawrence Washington, Assistant Results Engineer of the station.

# Some Steps in Boiler Building

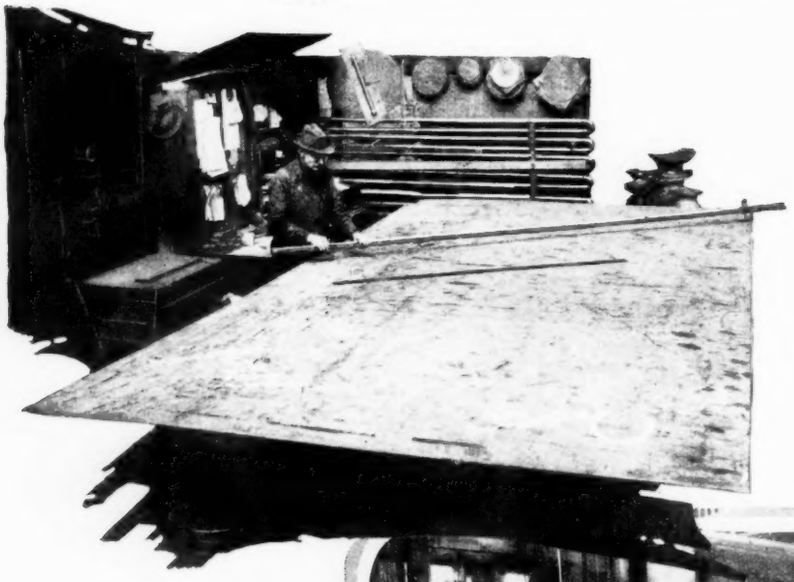


*Fig.1 (Left)—Laying out the rivet holes on the steel plate is the preliminary step in boiler building*

*Fig. 2 (Below)—After the rivet holes are punched and the plate cut to dimension, it is rolled into cylindrical form by this power-driven roll*

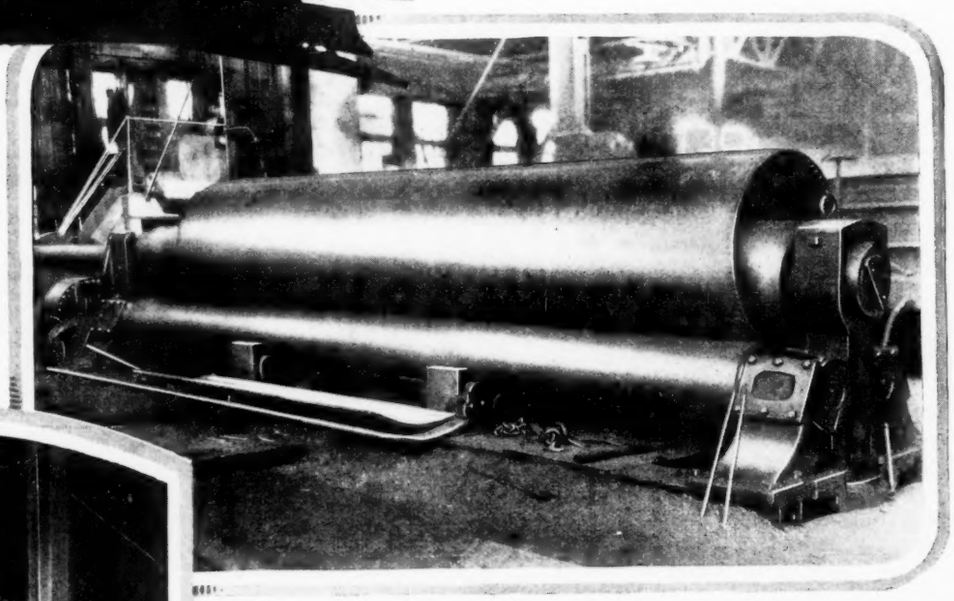


*Fig. 3 (Below) — The shell is riveted by a hydraulic riveter which exerts a pressure of 100 to 200 tons in squeezing the rivet to shape*

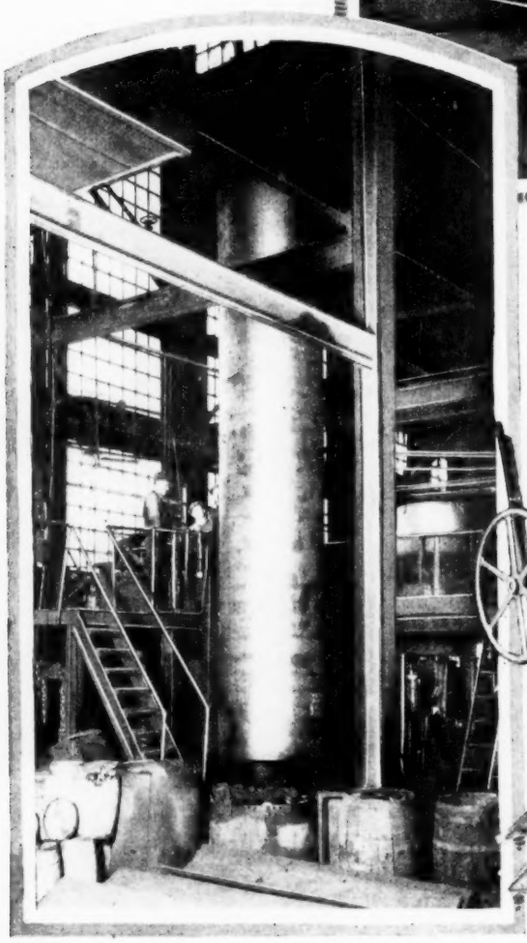
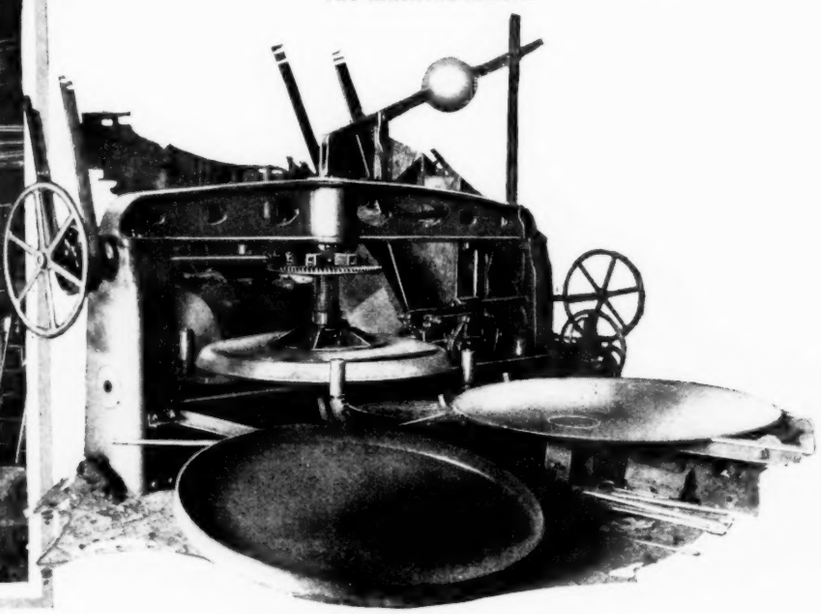


*Fig. 4 (Below)—One of the interesting processes is the spinning of the flange of the head. The circular plate comes red hot from a furnace and its edge is flanged by the machine shown*



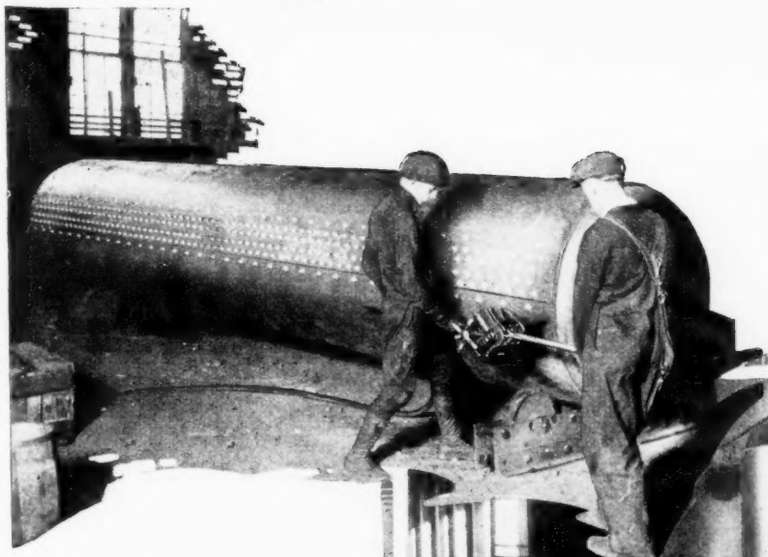
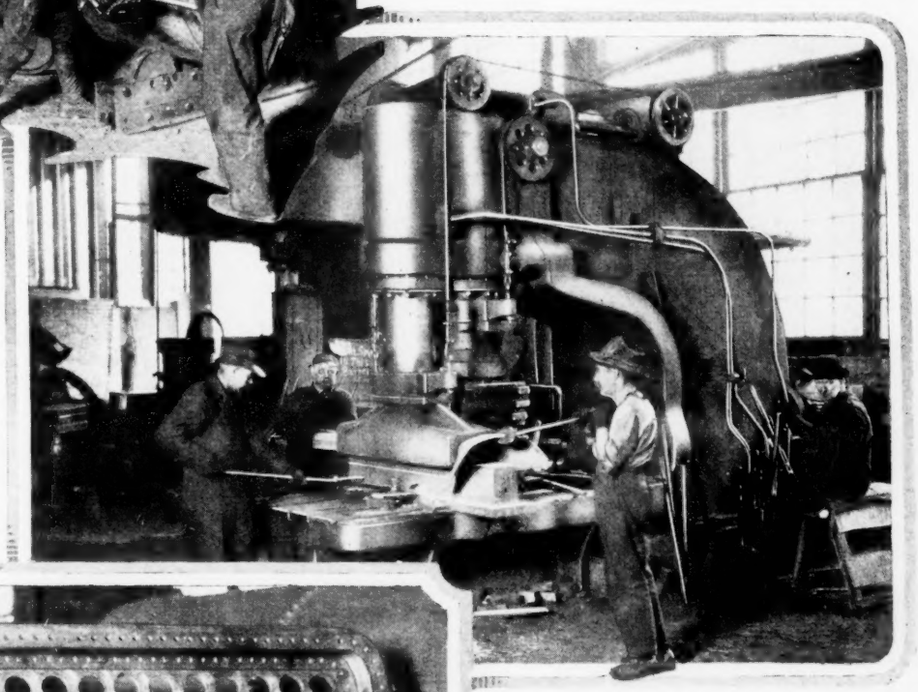


*Fig. 5 (Above)—The rivet holes are punched ¼ in. small, and reamed to size. This illustration shows the men reaming for the head joint rivets*

*Fig. 6 (Below)—The wrapper sheet of the steel header is hot pressed into exact shape by means of the hydraulic press shown below*



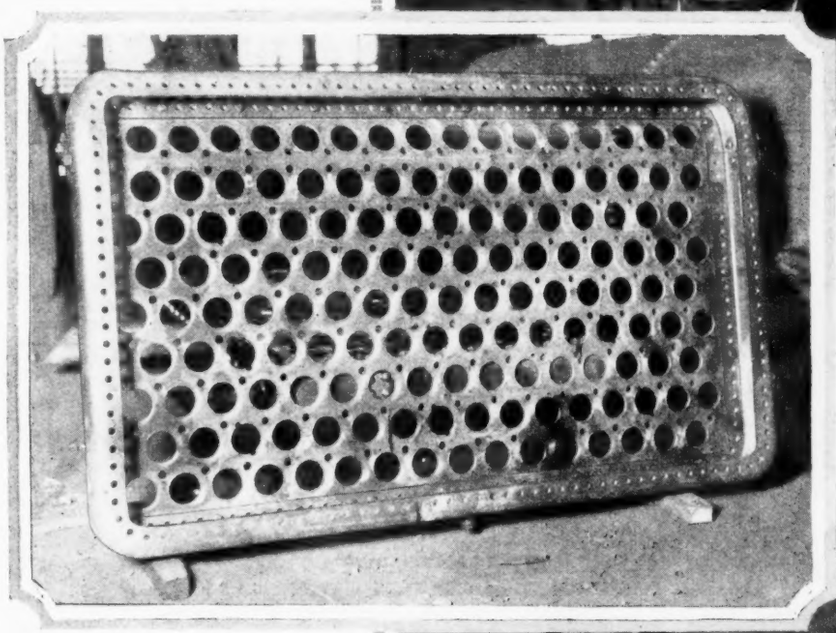


*Fig. 7 (Left)—This is one sheet of the header, with the wrapper or edge sheet in place*

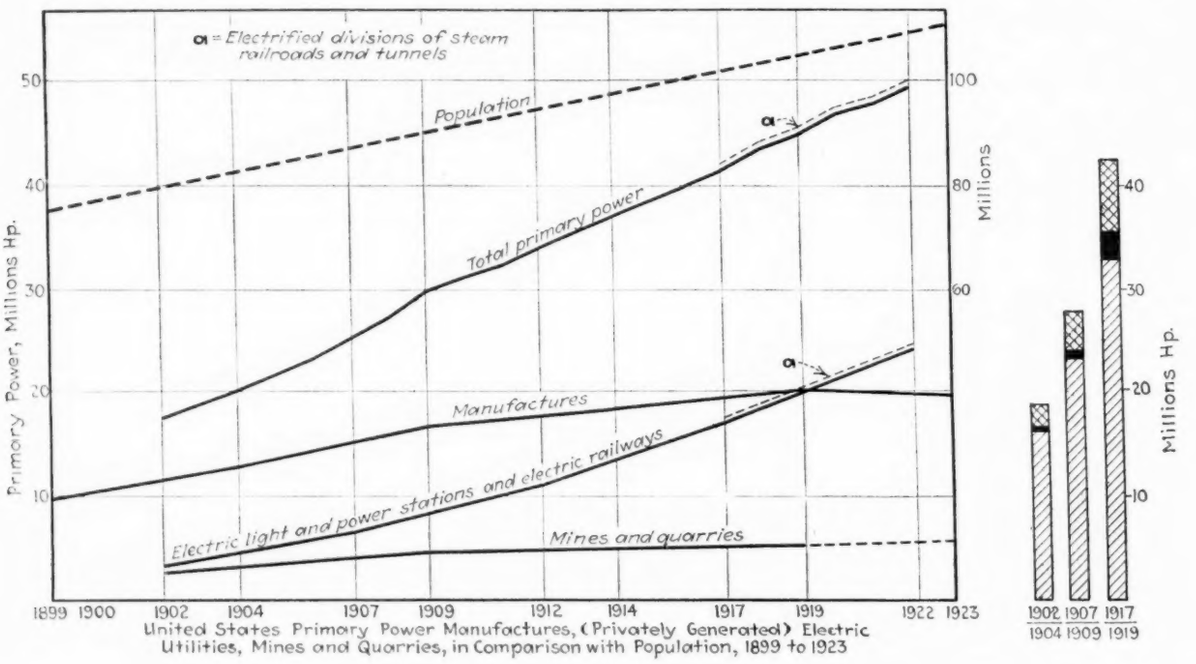
*Fig. 8 (Below)—The wrapper is riveted to the tube sheet by means of a pneumatic hammer*

The photographs showing boiler construction were obtained through the courtesy of the E. Keeler Co. in permitting one of *Power's* staff access to its Williamsport, Pa., plant.

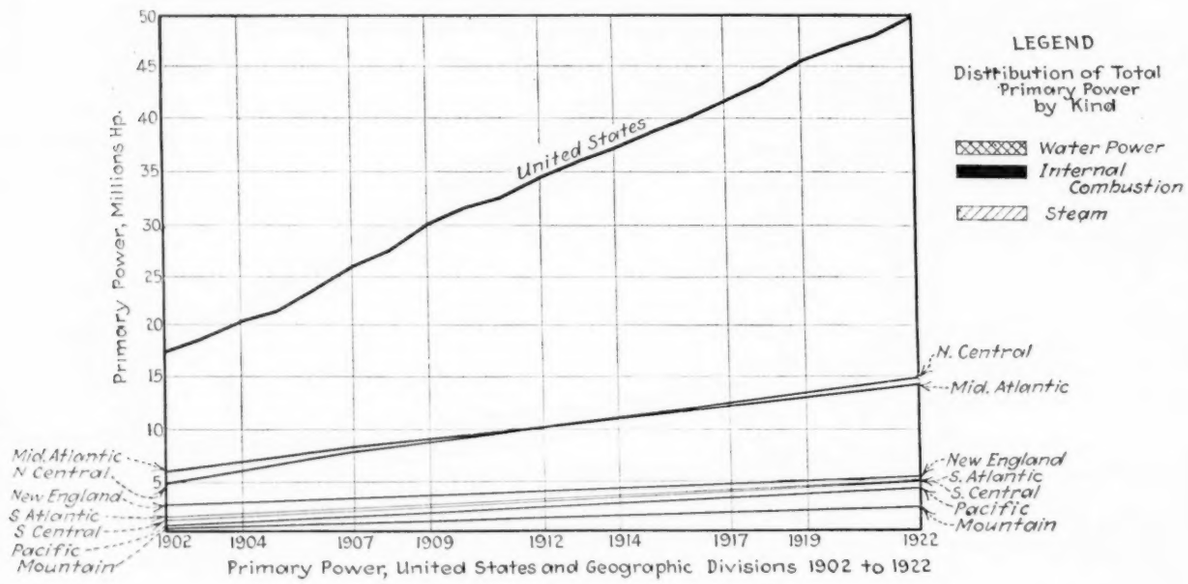
# Growth and Distribution of Primary Power

By STORY B. LADD

THE accompanying charts, based on the reports of the Bureau of the Census, aim to show the growth of primary power installations of the country. These reports give power statistics for the manufacturing industries in 1899, 1904, 1909, 1914, 1919 and 1923; for any one year, yet if we take the periods 1902-04, 1907-09 and 1917-19 as "group periods" for comparative purposes, we arrive at group totals. This is the basis of the accompanying charts, which give the statistics for the three components and an aggregate for the

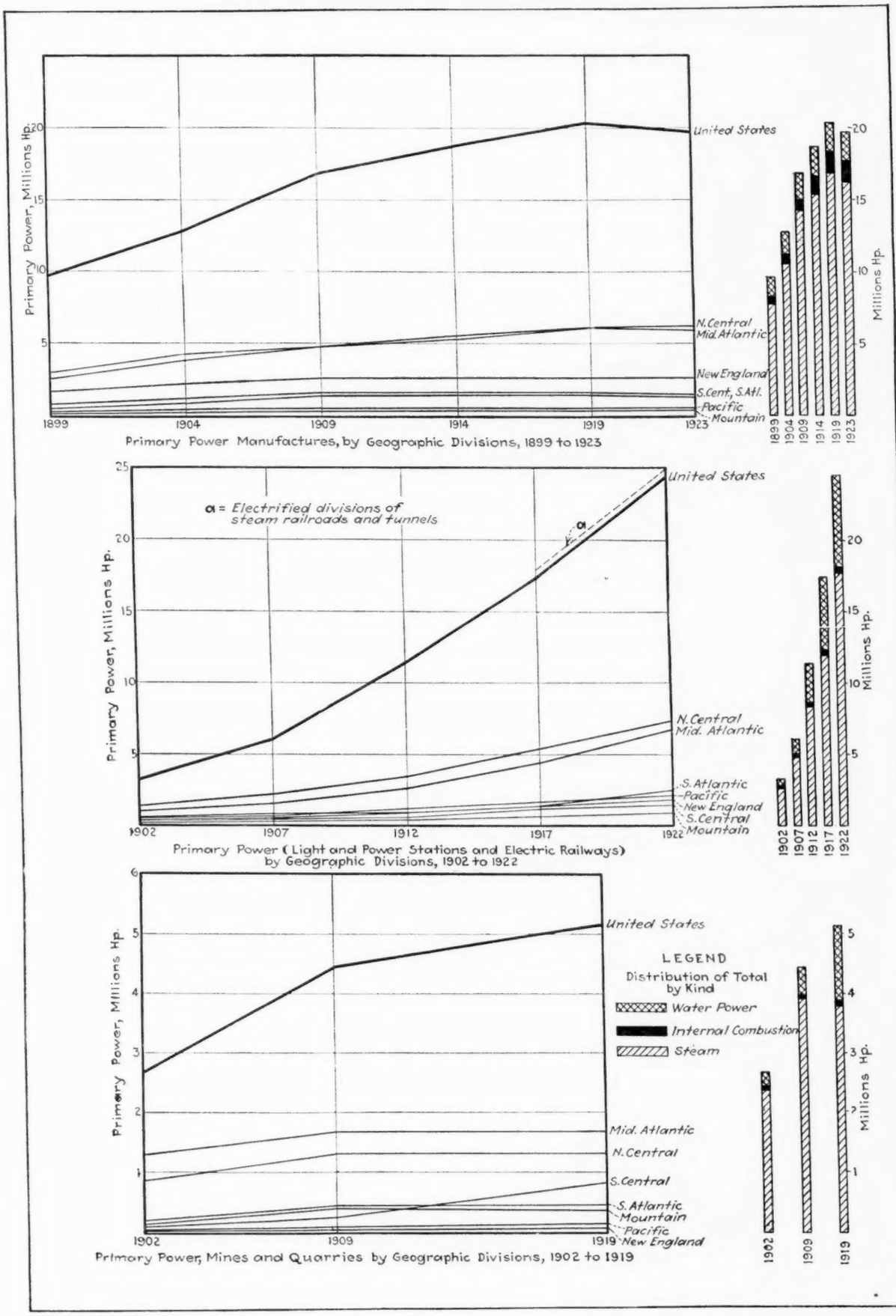

a = Electrified divisions of steam railroads and tunnels
Population
Total primary power
Manufactures
Electric light and power stations and electric railways
Mines and quarries
Primary Power, Millions Hp.
Millions
1899 1900 1902 1904 1907 1909 1912 1914 1917 1919 1922 1923
1902 1907 1917
1904 1909 1919
Millions Hp.

United States Primary Power Manufactures, (Privately Generated) Electric Utilities, Mines and Quarries, in Comparison with Population, 1899 to 1923




Primary Power, United States and Geographic Divisions 1902 to 1922

for the electrical industries in 1902, 1907, 1912, 1917 and 1922, and for mines and quarries in 1902, 1909 and 1919. Although there is not a lineup of all industries respective periods, the aggregate being distributed by geographic divisions; namely, New England, Middle Atlantic, South Atlantic, North Central (East North Cen-


Primary Power, Millions Hp.
United States
N.Central
Mid.Atlantic
New England
S.Cent, S.Atl.
Pacific
Mountain
1899
1904
1909
1914
1919
1923
Millions Hp.
Primary Power Manufactures, by Geographic Divisions, 1899 to 1923
a = Electrified divisions of steam railroads and tunnels
Primary Power, Millions Hp.
United States
N.Central
Mid. Atlantic
S. Atlantic
Pacific
New England
S.Central
Mountain
1902
1907
1912
1917
1922
Millions Hp.
Primary Power (Light and Power Stations and Electric Railways) by Geographic Divisions, 1902 to 1922
Primary Power, Millions Hp.
United States
LEGEND
Distribution of Total by Kind
Water Power
Internal Combustion
Steam
Mid. Atlantic
N.Central
S.Central
S. Atlantic
Mountain
Pacific
New England
1902
1909
1919
Millions Hp.
Primary Power, Mines and Quarries by Geographic Divisions, 1902 to 1919

tral and West North Central combined), South Central (East South Central and West South Central combined), Mountain and Pacific.

The first chart shows the primary power of the United States and the three components—Manufactures, Electric Light and Power Stations and Electric Railways, and Mines and Quarries—in comparison with population. The bar diagrams at the side show for the three periods 1902-04, 1907-09 and 1917-19, the distribution of total primary power by kind—water power, internal-combustion engines and steam power.

It will be noted that the curve for manufactures drops from 1919 to 1923, though the curve for total primary power continues to climb. Of course the curve for manufactures is not representative of total power consumed in manufactures, but only of the primary power installations. It is a large consumer of electric power from electric power stations, and this is true of mines and quarries.

The lower chart shows the primary power by geographic divisions. In 1902 the Middle Atlantic States ranked first and the North Central second, but by 1922 these positions were reversed. The other divisions ranked the same in 1922 as in 1902.

The second group of three charts shows the distribution of primary power installations for (1) manufactures, (2) central stations and electric railways and (3) mines and quarries, by geographic divisions, with bar diagrams showing the distribution of the total by kind—water power, internal-combustion engines and steam power.

It should be noted that the census figures do not take into account power plants in hotels, office buildings, hospitals, water works, public buildings, etc., where the power is not used for manufacturing nor sold as a commodity.

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How to Keep Cold Surfaces Dry—The "sweating" of cold metal parts about a power plant is, to say the least, annoying and unsightly, and may be troublesome if the condensation drips on electrical apparatus. This trouble is experienced in connection with condensers, pipe lines, pumps and the like, carrying cold water in the moisture-laden air of the power plant. The Philadelphia Electric Co. has used for years a simple method of insulating these surfaces so that condensation is effectively prevented. The metal is given a thick coat of red-lead paint, and when this has reached the "tacky" stage, ground cork is rubbed on by hand, the layer being made as thick as can be made to stick. This is allowed to dry and the surface is then painted with a finish coat.

# How to Fight Low Water in a Condensing Plant

BY J. R. JAMES
The Detroit Edison Company

*FALLING water level in the Great Lakes is a serious problem for plants in that region. The solution described in this article is an interesting adaptation of hydraulic-turbine practice to the steam plant.*

IN THE region of the Great Lakes, in both the United States and Canada, one of the main topics of conversation, especially with navigation interests, has been the continual lowering of lake levels. To one who reads the newspapers it would appear that the City of Chicago is to be blamed for the entire trouble. However, a scientific investigation reveals that the total change in elevation of Lakes Michigan-Huron may be proportioned somewhat as follows:

1. Forty-two per cent of the total lowering is due to lack of rainfall.
2. Twenty-six per cent is due to improvements in the Detroit River and to the fact that the difference of elevation between Lake Erie and Lake Huron in the last 25 years is less than in the previous 25 years. This last situation has been accounted for in part by some engineers as being the result of a tipping toward the west in this region of the earth crust.
3. Sixteen per cent is due to Chicago diversion.
4. Nine per cent is due to Lake Superior diversion and retention.
5. Seven per cent is due to Lake Erie diversion.

An examination of a chart issued by the United States Lake Survey, showing the monthly mean water levels of Lakes Michigan-Huron, indicates that starting in 1918 the high-water and low-water marks of each year have been steadily dropping at almost a uniform rate, the low-water mark in 1925 being 2.5 ft. lower than the low-water mark in 1919, and during these years there has been a marked deficiency in rainfall coupled with more than normal evaporation.

## An Uncomfortable Experience

One morning in February of this year at the Connors Creek plant of the Detroit Edison Company, when the load was coming on, the low-water alarms on the main circulating pumps started playing a lively tune. The cause, of course, was low water and a check of elevations showed that the stage of the river on that day was lower than anything on record since 1860. As already mentioned, the mean low-water mark for the month had been dropping at a fairly uniform rate, also the year 1925 was deficient in rainfall, and since lake levels have a lag, with respect to rainfall, of about two years, this would indicate still further reduction in lake levels. The winter of 1925-26, while not extremely severe, had continuous cold weather so that the ice in the St. Clair River was of considerable depth and this, in conjunction with prevailing low levels, brought about the extreme low water of last February.

In anticipation of another severe winter and of further fall in lake levels, the Detroit Edison Company made a study of the pumping situation at each power

house. The situation at Connors Creek seemed to be the most serious. One apparent solution of the problem would be to raise the level of the intake canal. This makes a very expensive program as it involves considerable construction and the purchase of a low-head pumping plant. It so happened that on the first three units it was possible to abandon the old suction of the pump and construct a new suction as indicated in Fig. 1. The seal on the old suction pipe was about 5½ ft. above the floor of the canal. The lower sketches indicate how this was changed by making use of what is called the hydraucone. In this installation the seal above the bottom of the pipe is 4 in., the bottom being 12 in. off the floor, requiring therefore only 1 ft. 4 in. of water above the floor to seal this suction in comparison with 5 ft. 6 in. to seal the old one.

### Advantages of the Hydraucone

The main point to bring out here is to show how useful this hydraucone can be, either to secure more seal for the suction pipe or to cut down the investment in canal work. An experiment was carried out to see when the seal would break on the vertical pipe by blocking off the intake canal entrance to the screen pit and throwing the control clear over on a 40,000 gal. per min. pump. The water lowered to within 1½ in. from the bottom of the pipe before air passed over. With 4 in. of water over the bottom of the pipe no air got by. This particular suction had a diameter of 3 ft. 5 in., but flared out

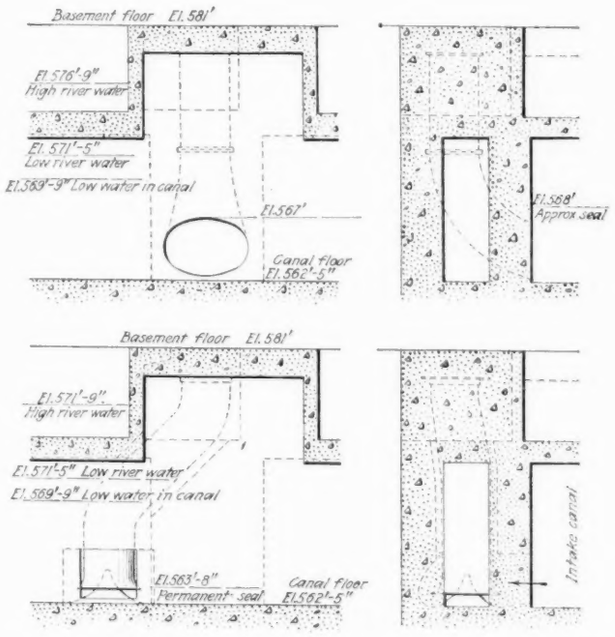
Basement floor El. 581'
El. 576'-9" High river water
El. 571'-5" Low river water
El. 569'-9" Low water in canal
El. 567'
Canal floor El. 562'-5"
El. 568' Approx. seal
Basement floor El. 581'
El. 571'-9" High river water
El. 571'-5" Low river water
El. 569'-9" Low water in canal
El. 563'-8" Permanent seal
Canal floor El. 562'-5"
Intake canal

*Fig. 1—Old and new suction pipes, the old above, the new below. Elevation along intake canal at the left, and cross-section at the right*

at the lower end to 3 ft. 11 in. When these pipes are made of cast iron this flare can be readily obtained, but when they are made of boiler plate it is somewhat cheaper to weld a truncated cone to the end of the pipe. When the welded boiler-plate job is used, it is best to blank off the top of the pipe in place and connect it to an air pump. The length of time the water level is maintained inside the pipe, after stopping the pump, is a measure of the efficiency of the welding job.

The hydraucone, a useful device on the suction pipe, is also good in certain situations on a condensing-water discharge pipe as well. For instance, it is often best to place the overflow canal directly above the intake canal, but the low water level will not ordinarily permit a horizontal discharge into such a canal and still be sealed, because to secure economy in construction, the floor of the overflow canal in many cases is not much

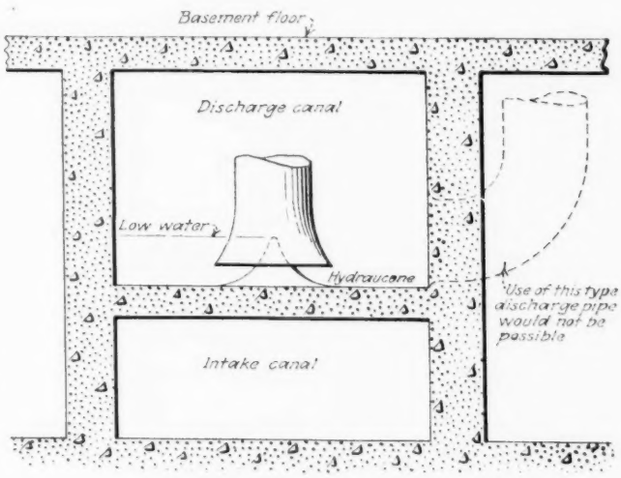


*Fig. 2—The hydraucone permits the location of the discharge canal above the intake*

below low water. However, by using the hydraucone this can be accomplished very nicely and in that way reduce the investment in the canal system quite materially. Fig. 2 shows this situation. It is important that the condenser discharge be kept sealed to secure the reduced circulating pump power resulting from the maintenance of an inverted siphon, which reduces the elevation head on the pump to the difference in equivalent water level in the two canals, which is often only a few inches, and rarely more than a foot or two. If the siphon breaks, this head jumps to the difference in level between the intake and the top of the condenser.

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An Interesting Modification of the scheme of identifying pipes by painting them various colors is that followed in a number of larger plants which have adopted a series of colors to designate materials within the pipes and another series of colors to designate services. The color designating the substance conveyed is painted on the body of the pipe, and the color designating the service supplied and the pressure, temperature, etc., is painted on all exposed flanges and valve bonnets. For example, steam is indicated by light green, water by dark green, oil by yellow, air by blue. In the second series, red may designate high pressure and temperature, black high pressure with ordinary temperature, white very low temperature, as for refrigerating purposes, and the like. A high-pressure superheated steam line will then appear as a light green pipe line with red flanges. A high-pressure oil line would appear as a yellow line with black flanges. A drinking-water line would appear as a dark green line with white flanges. With the increasing diversity of materials and services in the power plant, it seems as though some such scheme is almost necessary—at least if colors are to be used at all for designating pipe lines.

# Alternating-Current Motors—How the Induction Type Operates

By B. A. BRIGGS

*THE distribution of the magnetic field in the stator and the current in the rotor is explained, then it is shown how the resistance of the rotor winding affects the power factor and starting torque of the motor.*

IN AN induction motor the only part connected to the source of power is the stator winding. The rotor receives its power from the stator by magnetic induction very much the same as the secondary of a transformer receives its power from the primary winding. Sometimes the stator of an induction motor is referred to as the primary and the rotor as the secondary.

If the rotor of a phase-wound motor were locked so that it could not turn and the stator winding was connected to a source of alternating-current power, the rotor windings would deliver power the same as the secondary of a transformer. This, however, would not make a satisfactory transformer on account of the air gap in the magnetic circuit between the rotor and stator cores and other structural features. Nevertheless, the machine contains all the elements of a transformer, as well as those of a motor.

When a wound-rotor motor is started, it acts as a combination transformer and motor. Part of the energy delivered to the rotor by the stator is expended as mechanical power to bring the rotor and its connected load up to speed, and part of it is expended as heat in an external resistance.

In some alternating-current-motor speed-control sets the slip-rings of a wound-rotor motor are connected to the stator of another motor of the set and part of the energy delivered to the rotor of the first motor is transmitted electrically to the stator of the second motor, just as it might be from the secondary of a transformer, only at a frequency different from that of the power line. For this reason the wound-rotor motor in a speed-control set may be considered as a combination of a motor and frequency changer. This latter arrangement will be given further consideration in an article on the speed control of alternating-current motors.

In Fig. 1 is shown an elementary diagram of a two-phase induction motor, conductor groups $A$ in the stator being the winding for one phase and conductor groups $B$ the winding for the other phase. At the instant shown it is assumed that the currents in the two phases are of equal value, so that the currents in the different conductors are equal. The currents in the conductors will produce a maximum magnetic field at the points indicated as $N$ and $S$ poles. For example, the magnetomotive force produced by the current in the 8 conductors forming groups $A_1$ and $B_1$ is effective in producing a magnetic field at $N$ between $B_1$ and $A_2$, also at $S$ between $B_1$ and $A_1$.

If each conductor, Fig. 1, has 25 amperes flowing in it, the magnetomotive force available to set up the flux at $N$ and $S$ is equal to $25 \times 8 = 200$ ampere-turns. Dropping one conductor from each end of the

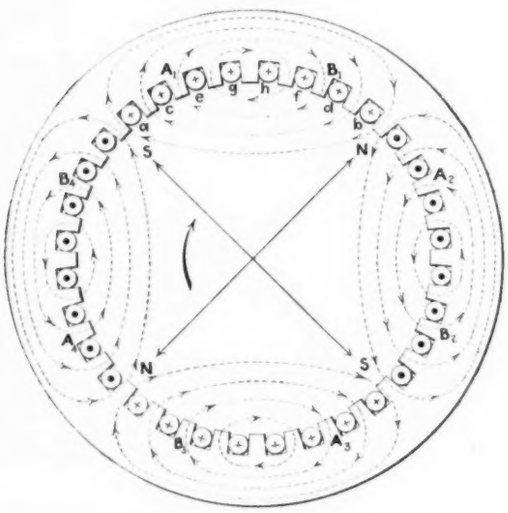



*Fig. 1—Diagram showing how the stator's magnetic field is distributed in an induction motor*

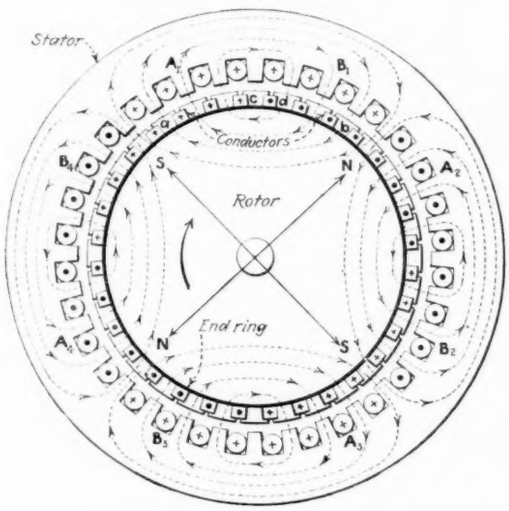



*Fig. 2—Diagram showing relation between the stator and rotor currents*

group as $a$ and $b$, the magnetic field set up about the 6 remaining conductors is that caused by $25 \times 6 = 150$ ampere-turns. Therefore the field between $a$ and $c$, also $b$ and $d$, will not be as dense as at $N$ and $S$. If another conductor is dropped from each end of the group, only 4 will remain and the magnetic field set up about them will be that produced by $25 \times 4 = 100$ ampere-turns. This is the field that will exist between conductors $c$ and $e$, and $f$ and $d$. Dropping conductors $e$ and $f$ from the group would leave only $g$ and $h$, and the magnetic field set up about them is that equivalent to $25 \times 2 = 50$ ampere-turns. Between these two conductors the effective ampere-turns is zero since one is in opposition to the other. From the foregoing it can be seen that the magnetizing force across the pole face varies from zero between $g$ and $h$, to 50 between $h$ and $f$, 100 between $f$ and $d$, 150 between $d$ and $b$, and 200 ampere-turns at $N$. If these values were plotted against the width of the teeth, a stair-step form of a curve would be had, as shown at the left above the horizontal line $XY$, Fig. 3. A similar curve would be had for the group of conductors $A_2$.

Conductors $B_2$ are effective in setting up a field in the opposite direction from $A_2$ group, or producing an $S$ pole between $A_3$ and $B_3$ groups of conductors. Since the polarity of the field produced between the $A_3$ and $B_3$ groups of conductors is reversed from that between $B_1$ and $A_2$, the ampere-turns would be represented by a curve below the line, as shown. This stair-step curve shows only the effects of the stator ampere-turns. The effect of the rotor current is to smooth out the steps and give a smooth curve as indicated, running through the steps. There are other ways of considering the distribution of the flux in the stator poles, but they are the equivalent of the foregoing.

## Generation of Current in the Rotor

In a previous article, "Alternating-Current Motors—Fundamental Principles," March 9, it was shown how

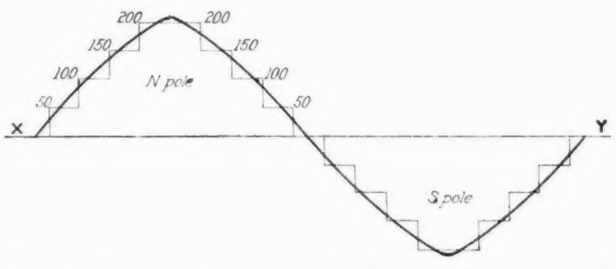



*Fig. 3—Curve representing the density of the magnetic field across the stator's pole faces*

the current in the stator's winding caused the magnetic field to revolve magnetically, in a manner similar to mounting the field frame of a direct-current machine in bearings and revolving this field mechanically. If the field revolves by the rotor conductors in the direction of the curved arrow, it will induce a current in them that will have a direction as indicated in Fig. 2. The magnetic field due to the $B_1$ and the $A_2$ groups of stator conductors is in the same direction, therefore the direction of the current in all the rotor conductors in this field should be the same. Under the $B_2$ and $A_3$ groups of stator conductors the magnetic field is reversed from that due to the $B_1$ and $A_2$ groups, so that the current in the rotor conductors under the former will be in the opposite direction to that in the conductors under the latter, as shown in the figure. It should be noted that the rotor will revolve in the same direction as the stator's magnetic field, or in the direction of the curved arrow.

Since the density of the stator's magnetic field varies across the pole face, the current in the rotor conductors in the field will vary with the strength of the magnetic field. This current will be at a minimum in the weakest field and at a maximum where the field

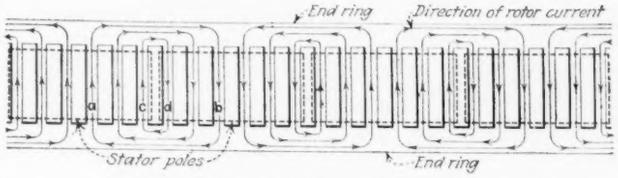



*Fig. 4—Rotor winding laid out flat to show flow of current*

is the strongest. As has already been shown, the most dense field is at the points marked $N$ and $S$ and the weakest is halfway between. Then, rotor conductors marked $a$ and $b$ in Fig. 2 will be carrying the largest current and those marked $c$ and $d$ the smallest.

## Distribution of Rotor Current

In Fig. 4 the rotor winding is shown laid out flat so as to show more clearly how the current circulates in the bars and end rings. In this figure a smaller number of rotor conductors is shown than in Fig. 2, so as to make the diagram more simple. The close loops and arrowheads represent the flow of the current and the dotted rectangles the stator poles.

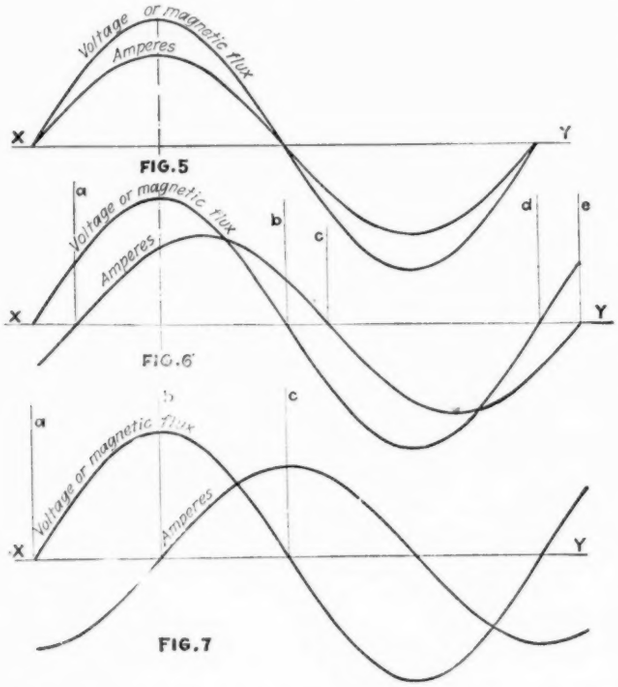
As has already been pointed out, the field at the center of the stator poles is the most dense and the rotor conductors in this position will have the highest voltage induced in them and therefore the maximum current. For example, conductors $a$ and $b$, or similarly located conductors will be carrying the maximum current. Conductors $c$ and $d$ are located between the poles and will be in the weakest field and will have a minimum voltage and current induced in them. The current is affected to a degree by the length of the circuit. For example, the circuit for conductors $a$ and $b$ is considerably longer than that for $c$ and $d$, as indicated by the length of the closed loops. This condition does not, however, affect the previous discussion and for all practical purposes may be neglected.

The condition shown in Figs. 2 and 4, where the current is flowing in the same direction in all the conductors under any one pole, is the ideal arrangement, as this would be the most effective in producing torque. This condition would exist only if the current in the rotor conductors were in step with the voltage or, in other words, if the power factor of the rotor were unity, something that does not exist in the normal induction motor.

The voltage generated in the rotor conductors by the stator's magnetic field will at all times be in step with the field, therefore the two may be represented by the same curve as in Fig. 5. If the power factor is unity, then the current curve will bear the relation to the voltage and flux curve shown in the figure. From this it is seen that the current passes through its zero and

maximum values at the same time the flux does, a condition, as previously explained, for producing maximum torque.

Owing to the inductance of the rotor winding, its current will lag behind the voltage and will therefore be out of step with the magnetic field. The effect of this can be seen from the curves in Fig. 6. For the period *a* to *b* the flux and rotor current have a certain relation to each other, both the curves being above the line. At the instant *b* the direction of the flux reverses




*Figs. 5 to 7—Curves showing relation between stator's magnetic field and rotor current*

but the current does not reverse until instant *c*. Because the current does not reverse during the period from *b* to *c*, it will produce a reverse torque from that existing during the period from *a* to *b*.

### Effects of Power Factor on Torque

What would happen from *b* to *c* is just what would take place in a direct-current motor if the polarity of the field poles was reversed without changing the direction of the current in the armature; namely, the direction of torque would be reversed. The period from *b* to *c* is so short, a few one-thousandths of a second, that the rotor does not have time to reverse, but the reverse torque is effective just the same and subtracts that much from the torque produced during the period from *a* to *b*. In other words, during the period from *a* to *b* the currents in the rotor and stator flux produce a torque that is effective in turning the rotor in a given direction, but during the period *b* to *c* the torque is reversed and tends to reverse the direction of rotation and reduces the effective torque from *a* to *b* by the amount produced from *b* to *c*.

During the period *c* to *d* the current and flux have both reversed and will produce torque in the same direction as from *a* to *b*. Then, from *d* to *e* there is another period when the current in the rotor has not reversed when the stator flux did, and a reverse torque is again produced. From this it is evident that the effective torque produced with a given value of rotor current cannot be as great when the current is out of step with the stator flux, Fig. 6, as when the current and flux are in phase, Fig. 5.

The farther the rotor current is out of step with the stator flux the lower the resultant torque developed by the rotor will be. If the current were lagging 90 deg., the resultant torque would be zero, since for one half of the current wave the flux wave of the stator is in one direction and for the other half of the current wave the stator flux is reversed. As a result for one half of the wave the torque will be in one direction and for the other half of the wave in the opposite direction, consequently the resultant torque is zero.

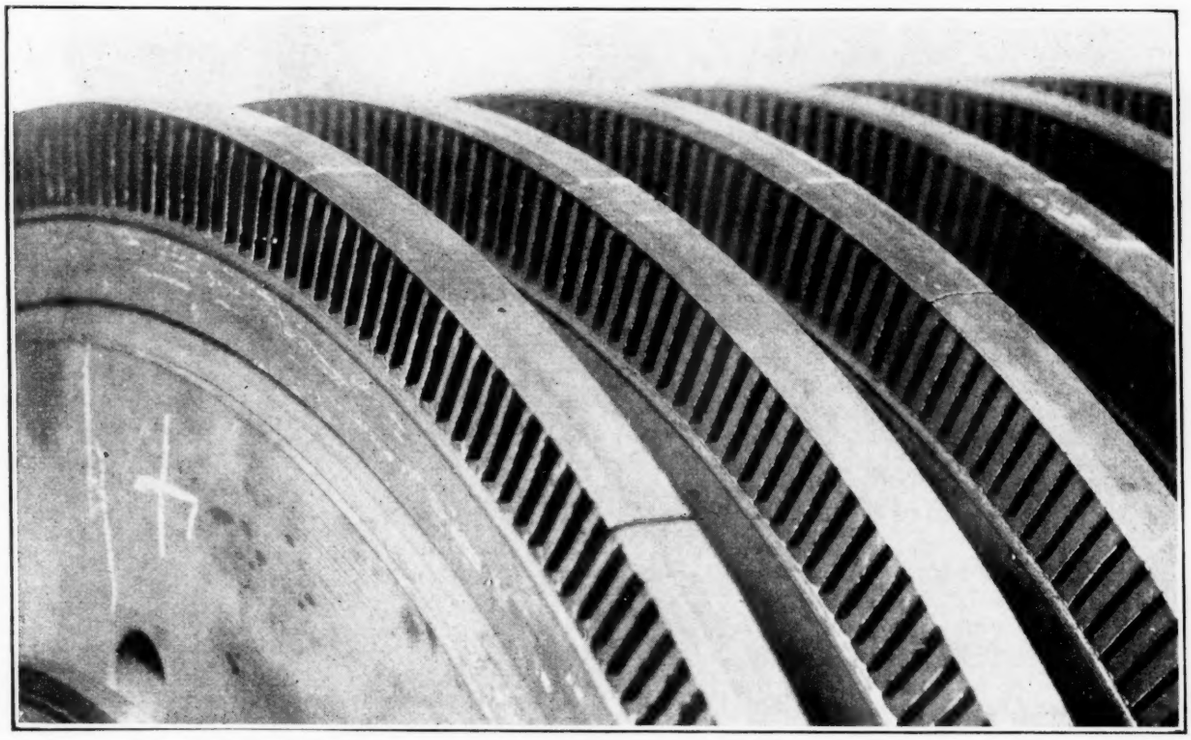
The foregoing will be understood by referring to Fig. 7, which shows one wave representing the stator's magnetic field and another representing the rotor current 90 deg. out of step with the former. From *a* to *b* the stator flux wave is above the line and the rotor current is below the line and would produce a torque in a given direction. For the other half of the wave from *b* to *c*, the rotor current has reversed and the wave is above the line the same as the stator flux. Since the rotor current has reversed and the flux is in the same direction as before, the torque will be reversed. As the values of flux and current are the same in each case, the torques will be equal, and as they oppose, no effective turning effort will be produced in the rotor.

### Resistance of Rotor Winding

From the foregoing it is apparent that if it is desired to obtain high starting torque in an induction motor, its rotor winding should be designed so that its current will be as closely as possible in step with the stator flux. This can be done to a degree by the resistance of the winding. If it were possible to design a commercial winding having resistance only, then the rotor current would be in step with its voltage. However, this is not possible, but commercial motors for certain applications, where they have to start and stop frequently, are designed with comparatively high resistance and produce full-load starting torque on about full-load current. One of the objections to such a motor is its low efficiency due to the high losses in the comparatively high-resistance rotor winding.

If it is desired to obtain high efficiency, then the rotor resistance must be kept low, in which case the starting torque per ampere of stator current will be low, caused by the high reactance of the rotor winding. The reasons for this low torque have been explained with Figs. 5 to 7.

The foregoing may be summed up by saying that a single-squirrel-cage motor cannot be designed to embody both high starting torque and high efficiency. On loads that start and stop frequently, such as elevators and hoists, good starting torque is of first importance and efficiency is of secondary consideration, so that a high-torque high-resistance squirrel-cage rotor motor can be used satisfactorily. If the service requires infrequent starting and medium or low starting torques, a low-resistance squirrel-cage rotor motor, having high efficiency, may be used. When the service makes it desirable to have high starting torque combined with high efficiency, then a motor other than a single-squirrel-cage type must be used, such as the double-squirrel-cage or the wound-rotor type.



*Buckets of first four stages, showing cutting at entrance edge*

# The 1,200-Lb. Unit at Edgar Station After Six Months' Operation

THERE are fields for exploitation and adventure in engineering as well as in science and geography. The experiment of the Edison Electric Illuminating Co. of Boston, in putting into commercial operation a boiler and turbine unit at more than double the pressure used in any existing station and four times the pressures ordinarily employed, has engaged the interest and attention of power-plant engineers all over the world.

The first stage of the demonstration has been completed, and it is *Power's* privilege to report the findings to date.

The steam temperature is no greater than those in ordinary use, but nobody knew what practical difficulties might be met with in the use of 1,200 lb. pressure or what the effects of using steam under this combination of high pressure and temperature might be upon materials and structures. Irving E. Moultrop, chief engineer of the Edison company, had the entire support and confidence of the directors in carrying out his ideas, and the makers of the apparatus, particularly the Babcock & Wilcox Co. and the General Electric Co., in the making of the boiler and the turbine-generator unit, applied the wealth of their experience and the facilities of their research departments to assuring, so far as it was possible to do in advance, the success of the project.

That there should have been some minor difficulties encountered is not surprising. It would have been too much to expect that so far-reaching an advance into unknown practice should be made without incident. The strange part of it is that what troubles have been encountered are not all attributable to the high pressure.

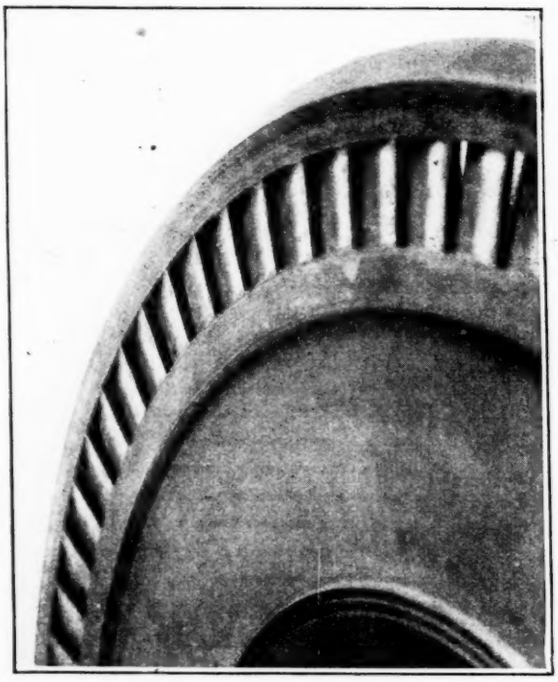
From the first there has been no trouble with the boiler or piping. The longitudinal joint of the turbine casing has remained perfectly tight and presents a beautiful surface with no sign of leaking. Even the exhaust connections, where it had been predicted trouble would occur under the 350 lb. exhaust pressure, have given no indication of leakage or distress.

The trouble that has been most difficult to overcome has been the vibration of the generator rotor. The original design of the turbine-generator unit did not contemplate the use of a speed governor, and it was expected that the output of the unit would be regulated by the quantity of steam supplied it from the boiler. This required the generator to be so built that it could be connected to the bus without synchronizing. Therefore the generator was designed with a synchronous winding on the armature and an induction winding on the rotating field. Later it was found practicable to install a speed governor, so this induction winding has been unnecessary. Apparently, some difficulty was found in holding the complicated winding on the rotor

rigidly in place due to the small space available, and trouble was experienced from vibration after the machine had been in use for a limited period of time.

The solution of this problem taxed the ingenuity of the General Electric engineers for some time, but was finally accomplished by the use of a self-adjusting bearing so completely that the unit has furnished 1,600 hours of commercial service, including a run of over three weeks without a shutdown.

The shaft packing at both the high- and the low-pressure end of the turbine was furnished initially with a carbon packing ring in series with some labyrinth packings. The carbon packing ring at the exhaust end of the turbine broke, throwing the rotor badly out of balance and causing some damage to blading and stage packings. In over-excess of caution the turbine rotor was taken back to the factory to see if it had suffered any distortion, but it was found to be still in perfect alignment.



*Fixed nozzles in one of the diaphragms*

When the turbine was reassembled, it was fitted with labyrinth packings of standard design such as the builder supplies with all turbines of its manufacture. It is only fair to say that this labyrinth packing was a part of the original design, but there were reasons why it was thought best to try a carbon packing. The diaphragm or stage packings originally supplied of the labyrinth type were not entirely satisfactory, and new packings of modified design were installed.

With these revisions the unit operated without further trouble. The personnel, who had regarded it rather gingerly at first, have gained complete confidence in it and come to handle it with no more regard than any of the ordinary apparatus of the station. It has been in service for several months with no shutdowns except those caused by slag accumulation on the boiler and other things incidental to the installation.

Recently, it was desired to make a check on the economy of the station with and without the high-pressure unit in service. This gave an opportunity to cool off the turbine and open it for examination. The general condition of the buckets and nozzles was satisfactory and in general the appearance was similar to what might be expected had the machine been operating under usual station conditions, with the following exceptions:

The blades of the first stage are only 0.613 in. in length and were found to be bent inward for about one-third of their length at the shroud ends as if they had contacted with a hard substance. This was true also of the second row and of the last two rows. The intermediate sixteen rows showed little if any of this action, neither was it apparent in the nozzle. There were upon the backs of the blades occasional small mounds of a dark brown powdery deposit.

The whole interior of the turbine, casing, diaphragms and disks was lightly covered with a bright red deposit like iron oxide. In places where the steam flow had been smooth, this was uniformly distributed but showed the effects of swirls where such had existed. In spots it had built up little mounds which, being scraped off, revealed pitting of the surface beneath them.

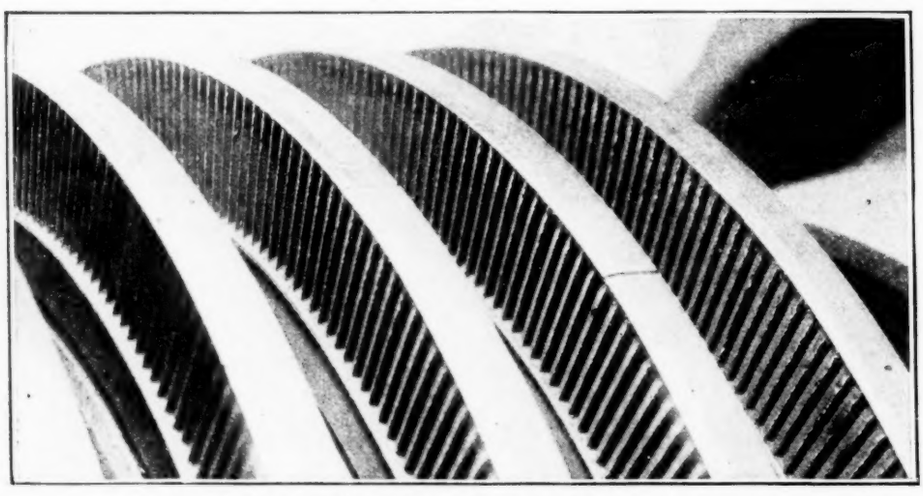
This corrosion is in evidence not only in the turbine, but in the valves and piping and even in the boiler—the 350-lb. as well as the 1,200-lb. units. Analyses of the deposit are being made.

The top speed of the blades is around 240 ft. per second, and the velocity of the steam roughly double this amount. The damage to the blades has more the appearance of a rubbing than an erosive action, and it is difficult to see why, if it is due to the carrying through the turbine of this powdery deposit, it should have ceased with the second row of blades to resume on the last two and had no effect upon the nozzles.

The piping system was blown out thoroughly to free it of pipe scale and anything that might be deleterious to the turbine before the unit was started up.

The distortion of the blades was not so serious but that they can be straightened and dressed without dismounting the rotor.

It is interesting that, although the bypass valve had operated much of the time under wiredrawing conditions and its interior was affected by the universally present red rust, its seat was in perfect condition.



*Buckets of the fifteenth to eighteenth stages*

## It Is Easy To Keep Plant Costs

WILL the excuses usually offered in answer to criticism of a lack of cost keeping in the power plant hold water?

The majority of operating engineers simply throw up their hands at the mention of costs, claiming that the attitude of the management makes all attempts to ascertain the power costs but wasted effort. They claim that it is impossible to obtain invoices covering fuel, supplies and repairs, and the conclusion is drawn that without this information an expense, or cost, sheet cannot be made to serve any useful purpose.

Admittedly, no complete set of figures can be drawn up without knowledge of every item entering into the cost of operation. However, fuel and labor make up from sixty to ninety per cent of the real operating expense. The engineer knows, or has it within his power to know, the amount of wages paid the plant employees. The fuel costs can be closely approximated by weighing the coal as fired and charging this at the market quotation on the grade used. True, this may permit a discrepancy to creep in, but it is seldom that a firm pays above the market price for any length of time, and after all, the potential cost of fuel is the price at which it can be obtained on the open market—a higher price is chargeable to management blundering.

Obviously, then, an engineer has access to the items that constitute the major part of the plant costs, and these items are the only ones that can be reduced to any appreciable extent. If a little effort be devoted to the problem, using the means that are at hand, the engineer can accomplish all that is really necessary in the line of operating costs.

In many instances where the engineer protests the loudest on the close-mouthed attitude of the office, the thing that is really hindering him is his own lack of initiative.

## The Labor Problem in the Power Plant

IT IS but natural that the wisdom of men is by no means proportional to the age of mankind. Each individual starts at the beginning, unable to talk, read or walk—helpless and ignorant. Gradually, with aid of adults who are wise only by comparison with his own ignorance, he picks up a few bits of knowledge and finally learns to get around on his own after a fashion. Then, if reasonably endowed by nature, he proceeds to acquire a little wisdom by the slow process of trial and error, making the same old mistakes that were made by his ancestors before him for thousands of generations.

Some lessons are never learned by mankind. Each generation insists on locating the clotheslines for itself by running around the back yard in the dark and getting hooked in the neck. The method is sure, but terribly painful and wasteful of precious time and energy. This is particularly true in the matter of learning to deal with our fellow-men. It takes the better part of a lifetime for most of us to learn how to work for and with others and to direct the work of others—some never learn. By the time we are proficient in this difficult art, it is generally about time to pass the job along to the next cradle graduate.

Nothing can help one more to get an early start and a good one than a willingness to learn of those who know from experience how to deal with men. At best one is bound to get many hard knocks and make a lot of mistakes, but the road can be smoothed by the kindly touch of an older and more experienced hand.

That is why *Power* is publishing in this issue the article, "Don't Underestimate the Plant Labor Problem." Full of homely wisdom, it tells what the "chief" has found out about human nature, and in particular about the men who work in power plants. The author for personal reasons prefers not to disclose his identity to the reader. However, he is chief engineer of a well known central station and has had a long and varied experience in the handling of power plant operatives. If you are a chief engineer, or hope to be some day, you cannot afford to pass up or to overlook this opportunity.

## Nothing to Be Feared in High Pressure Steam

THE twelve-hundred-pound turbine in the Edgar Station has been opened for inspection after six months of operation. The results reported on another page of this issue are distinctly reassuring. Thus far there is evident nothing to be feared from high steam pressure.

Indeed, there is nothing new to one accustomed to steam-turbine operation. Aside from the generator vibration, a difficulty almost unheared of in electrical machines of established design, there is not an item reported that has not been duplicated time and again in turbines operating at far lower steam pressures.

Red and brown deposits on the buckets, with pitting of the metal, are not new. Bad cases have been found at pressures around two hundred pounds per square inch. True, this is cold comfort, for the condition is disquieting wherever found, and its cause is difficult to identify and eliminate; but in any event, except for the possibility of an increase in the speed of corrosion, concerning which there is as yet no evidence, the damage is not chargeable to the high pressure.

Bent buckets here and there in a turbine are not uncommon, and the erratic way in which they are distributed in this case is not altogether unique. An explanation of cause and mechanism is always

baffling, but clearly the steam pressure was not responsible.

The mention of shaft packing and diaphragm packing troubles will arouse sympathetic understanding on the part of many an experienced turbine operator. This is an old story and has more to do with mechanical conditions, critical speeds and operating methods than with steam pressure.

That the bypass valve, which throttled steam of such high density, shows no signs of cutting may occasion some surprise, but it will not be disappointing, unless to those who lay bets on the fancied troubles of the future. If more extended experience shows that valves can be made to withstand the cutting action of high-pressure steam, a prolific source of anxiety will be dispelled.

High pressure is "selling itself" to the plant designer and operator. Costs and economies can be calculated and balanced, and in many cases, for plants large or small, a definite and substantial saving can be demonstrated. Special and new operating troubles, we begin to realize, do not bar the way of progress toward the realization of these benefits, for, so far as present experience indicates, there are no operating troubles peculiar to high-pressure steam.

## Combining Heating with Power Generation

WHEN the steam turbine made its appearance as a large prime mover about twenty-five years ago, it marked the beginning of the remarkable development in steam power-plant engineering that has taken place since. Increased blade speeds of the turbine and decreased exhaust pressures made material improvements in turbine efficiency. Following these developments came a wave of increased temperatures, which reached its limit in the metals available for the various fittings. Higher steam pressures followed in the wake of higher temperatures, and these have been carried experimentally to the critical pressure of thirty-two hundred pounds. Along with higher pressures and temperatures came the regenerative cycle, and designs of plants today permit using a steam cycle approaching the well-known Carnot.

While these developments have been going on in the steam end of the plant, marked improvements have taken place in the fuel-burning process; improvement in stoker design, burning of pulverized coal, improved boiler settings, economizers, air preheaters, and better control of combustion have all added materially to the over-all plant efficiency. As a result of these improvements a kilowatt-hour can be produced today with about one-third the expenditure of heat units that was required twenty-five years ago. However, even at that, about fourteen thousand heat units are required to deliver a kilowatt-hour on the busbars of the most efficient plants, operating under favorable conditions. This is the equivalent of about a twenty-five per cent over-all thermal efficiency. The possibilities of materially improving this in a straight condensing plant, even by going to a binary cycle, are not promising in the light of present experience.

Where it can be employed, the combined power and heating load provides the most efficient method of heat utilization. However, except in isolated plants this combination has not made much progress, although a few attempts have been made to apply it to district heating. Recent developments in high-pressure steam and turbines operating against high back pressures have again caused engineers to give careful study to the possibilities of central-station generation of power in combination with district heating. With such an arrangement a kilowatt-hour can be produced on considerably less than five thousand heat units, which is less than one-half of that predicted for the binary cycle. In some large cities conditions are favorable for supplying high-pressure heating steam and steam for power generation in condensing turbines from the same boilers, and low-pressure steam for local heating from one or more of the turbines. In one such plant, which has a load factor of twenty-six per cent for the power load, the load factor of the boiler plant is forty-six per cent. This high load factor on the boiler plant results in a considerable reduction in the cost of producing the steam under that possible, if separate plants were used for the two services. In other localities the proximity of large volumes of condensing water to congested districts opens up the possibilities of operating turbines non-condensing in the winter months to supply heating steam and power, and condensing in the summer months for power generation only. The use of very high pressure steam has also greatly improved the possibilities of combining power generation and heating service.

District heating for various reasons got a bad start and a worse reputation, which it has taken a long time to live down. However, those who have given careful study to these problems see great opportunities for it in the future as a means of reducing the cost of supplying heating and power to congested districts, when the two services are combined to take advantage of the possible economies. That which has been more or less of a necessary evil in the past, may prove to have been a blessing in disguise.

## Exhibition or Real Estate Scheme?

WHAT about the Sesqui? This question is being heard at clubs, meetings and in private conversations.

When propounded to Philadelphians, their local pride suffers and the replies are usually tinged with regret of what it might have been.

June first, the date of opening, has passed. True, there was a celebration, but little else, other than an administration building, a stadium, a post office and an empty fine arts building. As for exhibits, they were practically negligible.

Conceived in a splendid spirit, with the time propitious for making this a milestone among expositions, the Sesqui Centennial could well have depicted the tremendous progress in transportation, communication, labor-saving machinery and power generation since the Centennial of 1876.

However, owing to local politics and real estate jockeying, two-thirds of the time was consumed before a site was selected and an organization perfected. As a result, the occasion seems destined to be marked by little more than a number of athletic events, national conventions and some fine art exhibits, fringed by the usual exposition concessions.

It is no wonder that the Philadelphians, instead of swelling with local pride, bow their heads in silence.

# Practical Ideas From Practical Men

## Transformer Connections Used To Supply Power to Oil Purifier

In the electrical industry it is frequently necessary to resort to some special arrangement of standard equipment in order to obtain the desired operating conditions. Many times, as in the case herein described, desired results may be obtained at practically no cost or inconvenience.

Some time ago I had charge of dehydrating the oil in several banks of large transformers, where the filtering equipment was composed of a filter press, driven by a

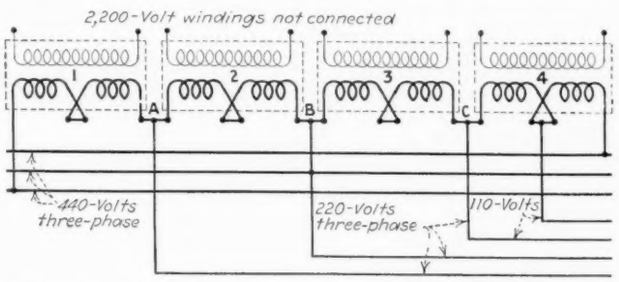



*Diagram of connections for obtaining 220-volt three-phase current from 440-volts three phase*

three-phase 220-volt motor. Several of the transformers were to have the oil filtered without taking them out of service, and these were rated at 13,200 to 440 volts. No inside taps were brought out from which 220-volt service could be obtained. There was neither 2,200- nor 220-volt circuits available, from which standard distribution transformers could be connected in the usual manner, for supplying service to the motor.

From the foregoing it can be seen that it would entail the purchase of other equipment, either transformers or filtering apparatus, which would mean quite an item of expense. The idea was conceived of using standard distribution transformers and connecting them as shown by the figure.

As the filter-press motor was only three horsepower, the smallest distribution transformers available, which were rated at 1 kva., would answer the purpose. This plan also had the advantage that the small transformers could be loaded in a one-ton truck along with the other equipment.

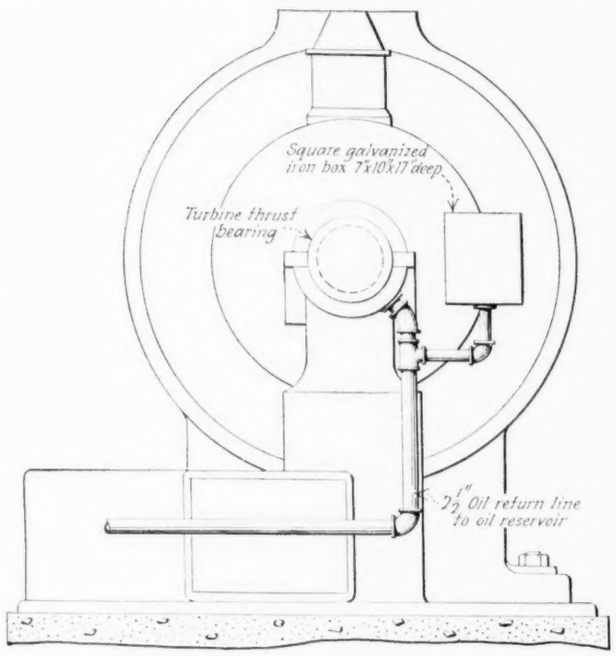
Four 1-kva. transformers with a voltage rating of 2,200 to 220 and 110 volts, were used. The secondary leads of the four transformers were connected two in series across the 440-volt bus of the large transformers, the combination then being connected, as shown, to form an open-delta connection. The leads to the motor were then connected to the junctions *A*, *B* and *C* between the transformers and 220-volt service obtained. A connection was made to the middle point of transformer No. 4, from which 110 volts was obtained for the transformer oil-testing set.

This made a convenient and compact arrangement, as everything was grouped under the eyes of the operator. It also had the advantage that a minimum amount of interference with attendants and operators around the plant or factory was caused. It is to be noted that only the low-voltage windings of the small transformers were used, the high-voltage leads being left open. The high-voltage leads should be well taped up, preferably using empire tape, then covering this with friction tape, to prevent injury to anyone who might come into accidental contact with these leads, which are energized to their full 2,200-volt rating. FRED C. DEWEESEE.

Raleigh, N. C.

## Air-Separating Tank Stops Oil Throwing on Turbine Bearing

After changing the thrust bearing on our 2,500-kw. turbine, we had trouble from oil throwing from the bearing. To eliminate this trouble, a settling tank was attached to the oil return line from the bearing, as




*Tank connected to oil return line from bearing to permit escape of air*

shown in the illustration. The tank was made 7x10 and 17 in. deep, which gave an area of 70 sq.in., allowing the air to become separated from the foaming oil. While there is a vent on each bearing to allow the air to escape, the one on this bearing apparently was not large enough to allow all the air to separate from the oil.

Lawrence, Mass. A. D. KANE.

## Pointers on Pipe Welding

In welding small nipples or pipes into tanks or headers, care must be exercised to see that the nipple will be square with the surface of the header or tank to which it is welded. The contraction on cooling may distort it to a degree sufficient to spoil the appearance of the work, and in the case of a long pipe, or one of

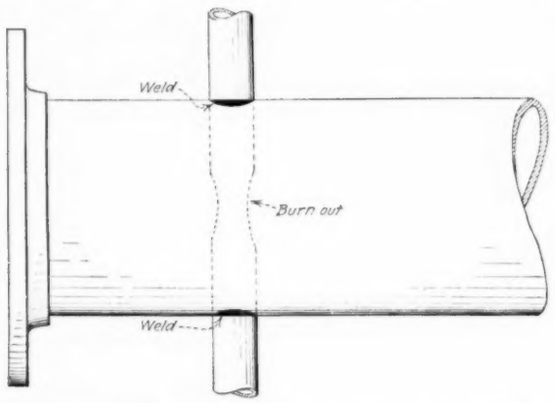



*Fig. 1—Hole is first cut in large pipe, then smaller one is slipped through and welded*

large diameter, to be of serious consequence. Where there is only one nipple to go in, there is not so much danger of this, especially if it is near the center of the header and with an equal amount of metal on either side so that the contraction is equalized. The contraction tends to close in the structure of the metal and

| No. | Actual Dim. A×B | Yield Point | Max. Load | Max. Area | Actual Area | Tens. St. Lb. per Sq. In. | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | 1.50×0.393 | 20,900 | 32,100 | 1.179 | 0.585 | 54,000 | Failed outside weld |
| 2 | 1.50×0.396 | 18,600 | 30,400 | 1.188 | 0.594 | 51,250 | " " " |
| 3 | 1.50×0.393 | 20,200 | 32,700 | 1.179 | 0.589 | 55,500 | " " " |
| 4 | 1.50×0.391 | 19,700 | 31,200 | 1.173 | 0.586 | 53,250 | " across weld |
| 5 | 1.49×0.401 | 20,400 | 32,500 | 1.195 | 0.597 | 54,850 | " " " |
| 6 | 1.50×0.396 | 19,900 | 32,000 | 1.185 | 0.593 | 54,000 | " " " |

Results on Welded Specimen

| No. | Actual Dim. A×B | Yield Point | Max. Load | Max. Area | Actual Area | Tens. St. Lb. per Sq. In. | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | 2.00×0.390 | 26,800 | 29,100 | 1.560 | 0.780 | 37,300 | Failed at braze |
| 2 | 2.01×0.382 | 27,800 | 31,800 | 1.536 | 0.708 | 41,400 | " " " |
| 3 | 1.99×0.395 | 27,400 | 29,600 | 1.57 | 0.886 | 37,650 | " " " |
| 4 | 2.00×0.387 | 26,300 | 36,800 | 1.548 | 0.779 | 47,560 | " " " |
| 5 | 2.00×0.385 | 26,600 | 35,900 | 1.540 | 0.770 | 46,600 | " " " |
| 6 | 2.00×0.393 | 27,900 | 28,900 | 1.572 | 0.786 | 36,750 | " " " |

Results on Brazed Specimen

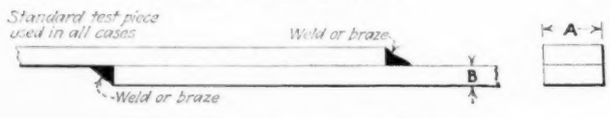



*Fig. 2—Comparative test of brazed and lap-welded joints*

pull the nipple with it toward the side of least resistance. It may safely be said that a large proportion of this type of pipe welds are far from being true, and have been remedied by a blow from a hammer.

A method of overcoming this difficulty is to set the nipple to be welded at an angle of about 5 deg. or have the free end, about $\frac{1}{16}$ in. for a short nipple, from the true and leaning toward the long side of the header; that is, the acute angle toward the amount of most metal. The contraction will usually be enough to pull the nipple square with the header. It may take a little practice to get the right amount of offset, but an experienced welder will soon get the right amount.

Where it is necessary to weld a number of small nipples into a pipe or header, a plan that is sometimes used is to bend the pipe so that there is a sag, or depression, of about $\frac{1}{2}$ in. in a 10-ft. length. The nipples are then welded in on this side. If the pipe has been bent too much, it will be necessary to heat the side away from the nipples and to cool it with water until it has straightened out. Where only two or three nipples are to be welded into a length of small pipe, some welders merely heat the far side, after cutting in the holes for the connections.

Where a cross has to be made or a connection of a smaller pipe into a large one, a practical method is to cut a hole in the big pipe and, after cutting a hole in the smaller one, to push it right through and weld in

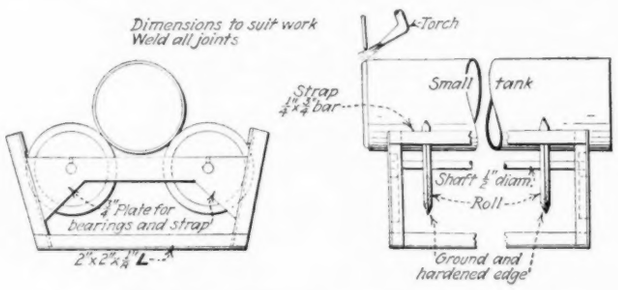



*Fig. 3—Rack for supporting work while welding*

place as shown in Fig. 1, rather than lay out a section of each pipe.

For gas mains, and connections to cast iron, brazing is much used, also for going around screwed connections to stop leaks. However, care must be taken that the heat is enough to get a good fusion, but not enough to burn the bronze. Samples of brazed joints subjected to a tensile test have closely approached a welded joint when pulled to destruction as indicated in the table, Fig. 2. A good fusion, with cast-iron brazing will show part of the metal coming away with the bronze if the heat has been properly applied.

Fig. 3 shows a small rack for use on pipes and small tanks, whereby they can be easily revolved while being welded. The frame is made from 2-in. angle iron, and has $\frac{3}{4}$-in. plates at each end to provide bearings for the rolls. The rolls are made from steel shafting cut and turned to a knife edge. A hole is bored in the center and the whole is trued up in the lathe and then case-hardened.

The rolls are then mounted on a short shaft as shown. Care must be taken to have the whole assembly true and square before welding. While the rack of this type that we built for our own use had no means of turning the work except by hand, a simple rig may be constructed by means of a wire and weight on one side of the pipe, with a ratchet and pawl actuated by a foot lever so that the operator could turn the pipe during welding.

MAURICE C. COCKSHOTT.
Hollywood, Calif.

# Comments from Readers

## Thought Belt Would Run to Low Side

In *Power*, March 16, I notice in the department, "What Happens and Why," the article starts off with "As everybody knows, a belt will rise to the crown of a pulley if it is given a little encouragement."

My experience proves that not everybody knows that a belt will run to the high side of a pulley. I once came in contact with a master mechanic who claimed that a belt would run to the low side of a pulley until I made a model and convinced him that a belt would run to the high side. When a cylindrical pulley was belted to a cone-shaped pulley the belt ran to the "high" side after the master mechanic had predicted the opposite. L. E. ANDERSON.

Pittsburgh, Penn.

## A Possible Remedy for Turbine Vibration

Referring to the article by F. B. Wheaton in the March 30 issue, in which he describes his experiences with turbine vibration, I should like to suggest a way of overcoming this trouble. If the rough running is due to a slightly bowed shaft caused from unequal temperatures on opposite sides of the turbine shaft, this could be overcome by providing some means of revolving the rotor slowly during the normal shutdown period.

This might be accomplished by connecting a small motor, through suitable gearing, to keep the shaft turning at, say, 10 r.p.m. Operating conditions, necessarily, would determine the best practice. If the length of time that a turbine remains shut down is short—say two or three hours—it would probably be best to keep the rotor revolving slowly. In other cases the "slow run" could be used for an hour immediately after shutdown, and it might be advisable to use it an hour with the throttle slightly open, before starting. EDW. E. KUEHL.

Verdigre, Neb.

## Separating Pipe Flanges To Insert Gaskets

Referring to the letter by Thomas Pascoe in the April 13 issue in which he tells how a carpenter's saw is used to clean the face of pipe flanges when renewing the gasket, I fail to see how he is going to put in a new gasket of the same thickness as the one removed if the saw he uses is thinner than the gasket, as he states. If he puts in a thinner gasket, he will have to use a still thinner saw when the second gasket is removed, etc.

However, it may be that the pipe lines to which Mr. Pascoe refers are under tension when cold, in which case the joints would separate when unbolted. Consequently, a gasket of the same thickness could probably be put in without any difficulty.

The old method of chiseling out gaskets is rapidly vanishing with the increase in the use of metallic gaskets combined with asbestos in such a way that the asbestos does not stick. These gaskets are thicker than ordinary sheet packing, but they are flexible, practically blowout proof and are made in sizes suitable for inserting so that the engineer does not have to cut out his gaskets from sheet packing. Gaskets of this type are easily removed as soon as a joint is broken, and they are as easily reinserted, saws or devices for separating the flanges, being unnecessary.

Newark, N. J. W. F. SCHAPHORST.

## Why Boiler Tubes Burn Out

Referring to the comments of Alex. M. Ormond in the April 27 issue on "Why Boiler Tubes Burn Out," my observation has been that Mr. Ormond's explanation seems more in accordance with the usual circumstances than Mr. Reinhard's. Several years ago I had an opportunity to follow up the installation of an oil-burning system in a large Eastern power plant, equipped with three water-tube boilers like the ones Mr. Ormond describes. Rear-shot steam-atomizing burners were used and the mixture was not particularly good. The flame entered the tubes in a band about 2 ft. wide just ahead of the front baffle and when the rating was pushed above 125 per cent the bottom row of tubes were burned out at an alarming rate, going in blisters in the path of the flame as has been described. This condition was remedied by a change in the atomizing system to give a more uniform flame and less concentration of the heat at one point on the tubes. An examination of the tubes removed for replacement and some showing small blisters demonstrated that while the boilers were amply clean for current practice in burning coal, there were small patches of closely adherent scale that caused trouble when conditions got just right with oil fuel.

Even perfectly clean tubes can be burned through if the heat is sufficiently intense, and I have seen photographs of a small tube-type marine boiler in which the evaporation averaged 15 lb. per sq.ft. per hour for four hours, in which a number of tubes burned through just above the lower drum on the furnace side.

New Haven, Conn. H. D. FISHER.

## Modern Pumping Engines in Holland

On page 539 of the April 6 issue, Professor Dyxhoorn tells us that the over-all efficiency of the pumping installation, results of which were published in the July 7, 1925, issue, was such that the term "high efficiency" as used was misleading. The letter of the professor does not explain very much and the first impression is still unchanged.

He assumes a mechanical efficiency for the steam engine of 0.90 and deducts an efficiency for the centrifugal pump of 0.306. Compared with the simple uniflow and the tandem-compound engine, this assumption might

prove to be a little too high. He calls an efficiency of 0.306 for a low-lift centrifugal pump not so bad. He also mentions that the pumps are designed for 3-ft. head and he means the difference in water levels. Then later on he remarks that the efficiency is low on account of the friction and losses in the pump and pipe lines. It is unusual to mix pump and pipe losses in that way.

It would seem that the data as presented are not dependable and they break down the favorable steam-consumption data for the steam engine.

The low-lift pumping installations of Holland are of interest to all pump designers, and for this reason complete scientific data should be published. A plan view of the installation, sectional drawings of engine and pump, test diagrams of the engine, test curves of the pump, average shaft horsepower, speed fluctuation, method of measuring head and output, might prove of interest.

G. VAN DEN BERG.

East Pittsburgh, Pa.

## Exhaust Versus Live Steam for Heating

Referring to the editorial, "Exhaust Versus Live Steam for Heating," in the April 13 issue, the following may be of interest, although not particularly enlightening from the directly scientific standpoint.

A 500-kw. turbine exhausting into a surface condenser, at 0 gage pressure, was installed in connection with a hot-water heating system, the circulating pump circulating the water through the condenser and supplanting the original live-steam heater. The surface condenser was drained with a hotwell pump so it was possible to weigh accurately the amount of steam passing through the turbine, and to calculate with considerable accuracy the heat being delivered to the heating system. Thermometers on the incoming and outgoing pipes on the condenser registered the two temperatures of the water. Live steam is also admitted to the surface condenser, so that the heating system can be operated without the turbine when there is no load to absorb power from the latter.

This apparatus was installed at the Beacon Manufacturing Co.'s mill in New Bedford and has been in operation for two winters.

I made a test of this installation to determine the total amount of steam used for various temperatures of the water, and the amount of power that could be realized under widely varying weather conditions. In connection with these tests the experiment was made of operating the turbine with a certain load, noting the temperature of the circulating water, and then stopping the turbine and introducing live steam through a reducing pressure valve at 0 gage pressure and maintaining the same temperatures in the circulating water. The object of this experiment was to find out if possible, whether the amount of steam passing through the turbine accounted for the mechanical work done as well as the heating effect, and if so, what the loss incidental to the conversion of heat into work might be in this particular case.

The surface condenser and all connecting pipes were well covered with heat insulation and it was expected that the losses would be small. The result of several trials failed to show any actual increase in the amount of steam used, when passed through the turbine, over that used when passing through the reducing valve, which, of course, could not have been in actuality and could be accounted for only through the fact that the errors in recording and noting temperatures, pressure and weight of water, were at least equal to the actual conversion of heat into work.

The experiments were repeated by using steam pressure in the condenser, corresponding to a 15-in. vacuum, and practically the same results were noted. This, of course, was all unsatisfactory from the point of view of the experimenter and proved the necessity of providing accurate testing equipment, and conducting the experiment for a sufficient length of time to eliminate errors or reduce them to a minimum.

From the practical operating viewpoint the most interesting observation was in the feed-water meter, which indicated the same amount of water fed to the boilers over a twenty-hour period, whether this small turbine was running or whether live steam was used direct, there being two other turbines in operation at the same time and carrying a steady load. The records of the mill show that 44,000 kw.-hr. per week was taken from this small turbine with no apparent increase in the amount of fuel burned or in the amount of water registered on the meter, as compared with operation without the small turbine. In other words, so far as it was possible to note the total cost of operating the entire plant, this 44,000 kw.-hr. appeared to be a clear gain except for fixed charges on the equipment.

It may be of further interest to some readers to know that it is possible to carry any temperature of water, as required by weather conditions, by simply adjusting tension screws on the turbine governor, letting the load take care of itself.

In this particular mill considerable power is purchased and whatever is obtained from the small turbine is practically net gain, with the total saving during the entire heating season sufficient to pay for the entire installation expense in two seasons. The combination of such apparatus with the hot-water heating system is as near ideal for minimum operating cost as one could hope for.

W. B. LEWIS.

Providence, R. I.

## Why Not a True Comparison of Public Utility and Industrial Power Costs?

A letter by Walter G. Diman in the April 13 issue on "Why Not a True Comparison of Public Utility and Industrial Power Costs?" brings out into the open a state of affairs that has a vitally direct bearing on the future of industrial power plants and those employed in them. Every well-informed person knows that in those parts of the country where central-station service is available in large blocks, numbers of isolated plants are being shut down and the power purchased. The supplanting of the individual plant by the central station receives wide publicity, but the rates paid for the new power are not advertised nearly so extensively.

Some of us who have had occasion to learn the prices at which large consumers of electric energy are able to purchase it have felt for some time that it is being sold far below cost of production if this cost was figured as it would be in any other business and included every legitimate item.

Factories such as steel mills, cement plants, copper refineries and others of that class are in excellent position to make their own power cheaply. They run 24

hours a day for 6 or 7 days a week, and their load factor is higher than a central station can hope to achieve under present conditions. Some of them, as open-hearth steel furnaces and cement mills, waste a great deal of heat up their stacks, and can, through the use of waste-heat boilers, make all or a part of their power from this waste heat. There are a number of cement mills that obtain all their power in this way, and they are heavy consumers, using from 14 to 22 kw.-hr. per barrel, depending on conditions in the mill and the nature of the raw materials.

Such plants use no coal for power generation, so that energy costs involve only interest, depreciation, obsolescence, taxes, insurance and operating and repair labor. Administrative expense is not included, since it is but a small part of that for the whole mill. As the load factor may be as high as 80 per cent, a kilowatt-hour can be made at a low figure.

When power may be generated in this way, cement-plant engineers consider that the dividing line between purchased and locally generated power lies about at 0.8c, per kw.-hr. That is to say, if central station energy costs much more than this it will pay in the end to install waste-heat boilers and a generating station at the mill, while if power can be bought for less than 0.8c. it will be better to get it in that way.

I must confess to a personal interest in this matter, for I designed and built one successful waste-heat generating station rated at 3,000 kw., and had hoped to build others. However, a canvass of the situation among cement mills brought out the fact that a considerable number of them are now buying energy. Many of them had had waste-heat power under consideration, but in each case the central station had offered a rate just low enough to cause the plans for local genera tion to be abandoned. I have seen power contracts based on 1c. per kw.-hr., have been told first-hand of one at 0.9c., and it is currently rumored that in the middle Mississippi Valley a rate as low as 0.75c. or less may be obtained. This last was at one time supposed to be hydro-electric power, but now much of it is the product of steam stations.

No blame attaches to the purchaser of power at these low figures. He is like any other business man, trying to get the most for his money, and if he can buy energy for less than it would cost him to make it he would be foolish not to do so. The reflection is rather on the central station that is willing to sell at such rates and the Public Service Commission that permits it to be done, for the true economic validity of such prices has not been established to the satisfaction of the general engineering fraternity.

C. H. SONNTAG.

Cape Girardeau, Mo.

## Improvised Air Filter for Air Compressors

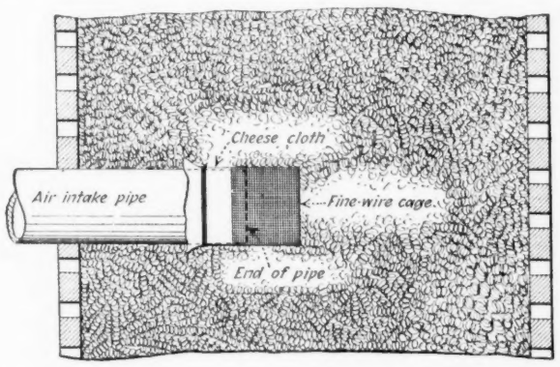
In the March 30 issue C. G. L. Huether makes some interesting comments on my letter describing an improvised air filter for air compressors, which appeared in the Jan. 12 issue. Mr. Huether casts some doubt on the value of the air filter I described, and I therefore wish to make a reply.

He states that the oil-coated steel-wool type of air filter would not be practical. This type of filter has been used in a considerable number of plants for some time now and has proved practical indeed. It will not clog up in "a very short while," as he intimates, if it is made of ample size. Of course if the air is very dusty, more frequent cleanings will be necessary, but that is true of any type of air filter.

Mr. Huether states that the flow of air through the cheesecloth on the end of the suction pipe would concentrate a lot of dust at that point and clog it up rapidly. Just where this dust would come from is not clear, since the air is well cleaned by passing over the large oily areas offered by the extended surfaces of the steel-wool threads. Most of the dust is removed in the first two or three inches of travel through the steel wool. With a pipe opening in the center of the filter of four times the cross-sectional area of the regular intake line, as suggested in my previous article, the air velocity will be low.

As for clogging elsewhere in the filter, that does not occur, since the air flow is distributed over a great number of entrance holes; the amount of dust going in each hole is so small that it will not clog the entrances for a long time.

Any particles of steel wool that get broken off are caught on the cheesecloth, as they are rough and tenacious to cloth. In line with Mr. Huether's suggestion, a fine wire sleeve with a covered end may be put over




*Fine wire cage over end of suction pipe prevents small pieces of wire reaching the cloth*

the end of the suction pipe, as illustrated herewith, to hold the steel wool away from the cheesecloth. Any stray bits of steel wool would then fall to the bottom of the sleeve and not get to the cheesecloth.

There is no objection to small amounts of atomized oil entering the compressor provided the oil used is a regular air-compressor oil. Mr. Huether suggests the use of a filter employing a viscous oil. I presume he means a steam-cylinder oil. This type of oil is unsuitable for air-compressor cylinders. I would consider it a dangerous material to introduce into the air cylinders, as it is likely to gum and carbonize on the discharge valves, resulting in leaks, "wiredrawing" of the air and possible overheating and explosion.

While it is possibly true that the average commercial filter will give better service than the one described in my previous article, it is also true that many operators do not wish to incur the expense of a manufactured one and would rather have an effective apparatus that costs little to build and maintain.

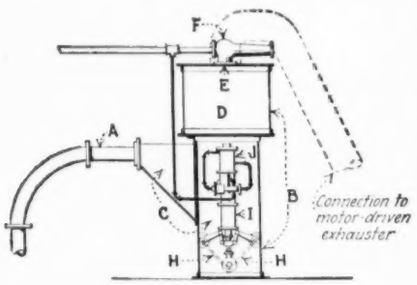
I am glad Mr. Huether has brought the subject up, as it emphasizes the importance of clean air for air-compressor operation to do away with carbon and valve troubles, which are so largely a product of dusty air.

New York City. G. H. CORNELL.

# New and Improved Equipment

## The "AroCarrier"

In the material-handling field a recent development is the "AroCarrier," a pipe-line conveyor using air as the carrying medium and a steam or rotary exhauster to create the motive power. As the steam does not come in contact with the material being handled and has no other function than to establish the air flow at the desired velocity, the




*New pipe-line conveyor*

conveyor proper is purely of the pneumatic type. Field demonstrations have proved its adaptability for handling a wide variety of materials such as sized coal, ashes, grain and other granular materials.

Referring to the sketch, the receiving end of the conveyor is a conduit or pipe line *A*, with one or more openings into which the material is fed. For capacities of 5 to 50 tons an hour this pipe line may be varied from 4 to 8 in. in diameter. Tentative limits for the horizontal run have been placed at 300 to 400 ft. and for the vertical rise 70 to 90 ft. The conduit terminates in an operating head *B* divided into two zones, the lower compartment *C* being termed the accumulator zone and the upper section *D* the suction zone.

At the top of the suction zone the outlet *E* leads into an exhauster *F* of the steam-jet type using steam at plant pressure through multiple nozzles, or a motor-driven rotary exhauster. The accumulator zone has two openings, one providing for the admittance of the material from the pipe line and the other the flap gates *H* coming together at the center and pivoted at the sides to form a V-shaped bottom to this compartment.

To operate the conveyor the exhauster is started, drawing the air from the operating head through the suction zone. As the gates *H* are closed, the only place through which air can be drawn to replace that evacuated from the head is through the conduit *A*. In this pipe line a current of air of sufficient velocity and volume to carry the material is established. As the material is introduced, it seeks the central portion of the pipe where velocities are greatest and is borne along in the air stream with little or no degradation to the operating head. Here the sudden enlargement of volume and the consequent slowing of velocity allows the material to drop into the accumulator, while the air turns upward into the suction zone, winding through a series of baffled passages toward the outlet. Large areas and low velocities still maintain, so that the finer particles that may have been carried along with the air, drop back into the accumulator and the discharge from the exhauster is free from dust.

When a predetermined weight of material has accumulated, the gates are released automatically by means of the hydraulic cylinder *I* and a regulator, dropping the stored contents of the receiver or accumulator to a hopper, pile or open car below the operating head. By steam or compressed air in the cylinder *J* the gates are restored to their original closed position, sealing the operating head, and a repetition of the process of accumulation takes place. Thus the operation of the conveyor consists of a recurrent number of accumulations, obtained through the pipe line *A*, and discharging at regular intervals. The cycle of opening the gates, discharging the material and again closing the gates requires a period of time not to exceed 1¼ seconds. The time required for accumulation depends on the capacity of the equipment and the weight it is desired to accumulate, which in the standard sizes may be adjusted up to 1,000 lb.

In more detail the gate operating mechanism consists of two cylinders in tandem, the oil cylinder for opening below, and above the steam or air cylinder for closing. The two pistons are mounted on a common rod which extends below the oil cylinder to support an arm from the gate pivot on either side. These arms transfer the weight of the accumulating material to the piston rod. With the gates closed, both pistons are in the up-position. The lower cylinder is filled with oil, so that the hydrostatic pressure builds up as the weight of material in the accumulator increases. At the predetermined point previously mentioned, the regulator functions, equalizing the pressure above and below the piston, so that the latter is pulled down by the weight of material as rapidly as the oil can be transferred, and the gates are open. As the piston reaches the bottom of the stroke, the steam valve is tripped and the steam cylinder performs the upward, closing operation.

Tests on the steam-jet exhauster equipment were conducted on 2-in. Kentucky screenings, stoker ash, combustion chamber dust and a quantity of oats. With the ashes an hourly capacity of 23.6 tons through the 5-in. suction line was obtained and the steam consumption approximated at 118 lb. per ton of ash.

Under license from the patentee for the United States and Canada the "AroCarrier" is manufactured by the Conveyors Corporation of America, Chicago.

## Manzel Model 77 Lubricator for Diesel Engines

The Manzel Brothers Co., Buffalo, N. Y., has recently extended its line of force-feed lubricators with the addition of Model 77, shown in the illustration, which has been designed especially for Diesel-engine lubrication.

The lubricator is built on the unit principle, a number of individual pumping units being placed in a central tank or reservoir, with one complete unit for each point to be lubricated. Each unit consists of a single plunger pump *A* (see Fig. 2) which is operated through a cam lever *B* by the cam *C* on the hexagonal drive shaft *D*, the shaft *D* in turn being driven by ratchet or other movement from some moving part of the engine. As will be

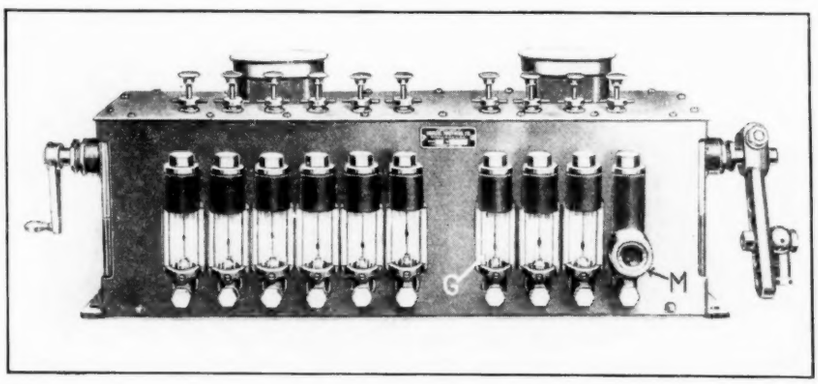



*Fig. 1—Two-compartment lubricator having six engine and four air compressor feeds*

seen by a study of Fig. 2, no intake valve is used, the plunger itself opening and closing the intake port.

In operation, the upward stroke of the plunger causes oil to be drawn through the strainer *E* into the small pocket directly below the plunger; on the return of the plunger the oil is forced out through the valve *F* and the sight glass *G*, which is filled with glycerin to the oil feed line *H*. A wire in the center of the sight glass guides the drops of oil and prevents them from touching the sides of the glass.

The feed of each pumping unit is adjusted independently and may be set to supply particles of a drop per stroke or increased to a maximum of five drops per stroke. The regulation of the feed is accomplished by raising or lowering the position of the cam lever *B* on the regulating screw *J*. This is done by turning the feed regulator *K* on the top of the oiler. This regulation may be made while the pump is in operation. The timing of the oil delivery to the cylinders is effected by setting the driving cams *C* at the proper position on the shaft *D*.

An individual hand pump is provided for each pumping unit, enabling the operator to flush any cylinder at will.

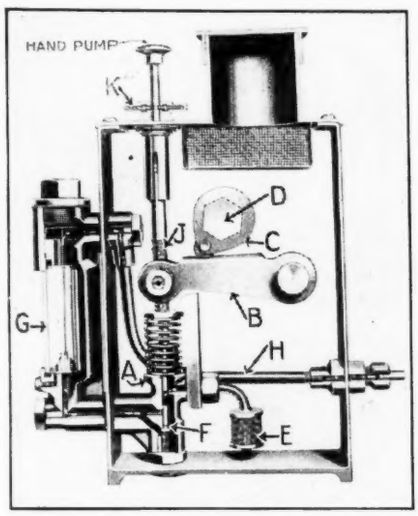



*Fig. 2—Details of lubricator*

In addition certain models are fitted with a hand crank on the drive shaft by means of which all pumping units may be operated simultaneously by hand. Tubular sight feed glasses *G* are used for pressures up to 400 lb., but for higher pressures the bulls-eye sight feed *M*, shown in Fig. 1 is furnished, it being designed for pressures up to 1,500 lb.

The lubricator shown in Fig. 1 is the two-compartment model having six feeds for the engine cylinders and four feeds for the air compressor.

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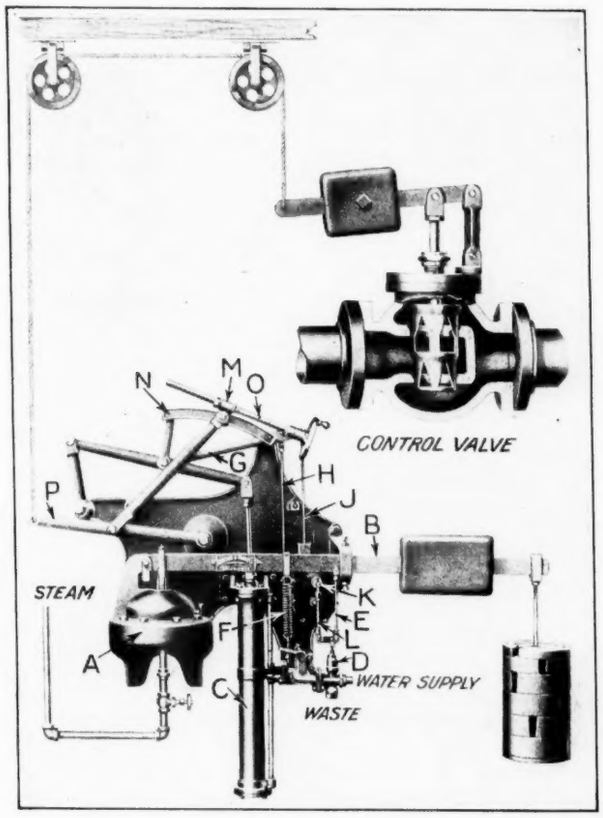
**Sampling and Examination of Mine Gases and Natural Gas,** Bulletin 197 of the Bureau of Mines, deals primarily with matters outside the power field. The detailed discussion of gas analysis does, however, give side lights of interest to power engineers concerned with accurate gas analysis.

## Atwood-Morrill Adjustable Pressure Regulator

A type of regulator designed for controlling the speed of a stoker or fan engine, position of damper or other unit, in which the operation is on the step-and-stop principle, has been brought out recently by the Atwood & Morrill Co., Salem, Mass.

By step-and-stop principle is meant that the regulator moves only slightly at each definite change in the boiler pressure and, having stopped at some point in the stroke, will remain there until there is another definite change in the boiler pressure, when it will open or close the controlled valve or damper a definite amount and remain in the new position until moved again as just described.




*Regulator operates on the step-and-stop principle*

The regulator consists essentially of a diaphragm and pressure chamber *A*, a weighted lever *B*, a hydraulic operating cylinder *C*, a pilot valve *D* for controlling the water to the cylinder and the necessary connecting links as shown in the illustration.

The steam-pressure connection is made to the chamber *A* below the diaphragm. As the weighted lever *B* moves with each definite change in pressure, the pilot valve *D* is also caused to move through the connecting link *E*. The step-and-stop movement is accomplished by increasing or decreasing the tension on the compensator spring *F* which is connected to the lever *B* at one end and the lever *G* at the other through the link *H*. This increase and decrease of the tension on the spring, together with the intermittent opening and closing of the pilot valve, produces the step-and-stop movement. It will be seen that any movement of the hydraulic piston will impart movement to the lever *G* and link *J*, which in turn through gearing and crank *K* converts this movement into a rotary motion, causing an up and down movement to the link *L* and an opening and closing of the pilot valve *D* regardless of whether the piston is moving up or down. Thus it will be seen that a number of such movements are given to the pilot valve for each full travel of the piston, the primary pilot valve movement being transmitted from the lever *B* by the link *E*.

Another feature of the regulator is the provision made for controlling the amount of opening of the controlled valve or damper. This is effected by moving the block *M* along the sector *N* by means of the screw *O*. This adjustment makes it possible to vary the travel of the operating lever *P* from practically nothing to a full travel of about 15 in. In the illustration the block *M* is shown about mid-position, which gives a ratio of travel of the lever *P* to the hydraulic piston of 0.5. With this adjustment anything in pipe capacity from full area down to practically nothing can be obtained, the change being readily made with the machine in operation.

The application of this regulator illustrated is only one of the various uses to which it is adaptable. The valve shown is a double-seated balanced valve designed to give very close regulation.

# Pitting of Hydraulic Turbine Runners

## From Data Obtained on 225 Units the Conclusions Are Drawn That Pitting Is Caused by a Vacuum Forming on the Bucket Surface, Due to Excessive Draft Head or Improper Design of the Runner. Methods of Prevention and Repair Are Suggested

EARLY in 1924 the Hydraulic Power Committee, of the National Electric Light Association, through its subcommittee, undertook to bring together experience data of operating companies throughout the United States and Canada regarding the pitting of hydraulic turbine runners, in order that a logical basis of analyzing the causes of pitting might be found and ways of eliminating pitting proposed. Prior to that time there had been no concerted effort by operating companies or turbine manufacturers to give out information relative to pitting.

The work of collecting experience data was started in January, 1924, when inquiries were sent to companies all over the country asking for specific information. The response at that time and since was so generous that statistics have now been secured from 225 different turbine settings representing about three-fourths of the total hydraulic turbine generating capacity installed in the United States.

By March, 1924, data had been obtained from about 70 installations, and a preliminary report was hastily prepared for incorporation in the 1924 convention report of the Hydraulic Power Committee (N.E.L.A. Publication No. 24-28). This report advanced tentative conclusions as to the causes of pitting which were calculated to provoke comment and pave the way for a more comprehensive and conclusive report when the collection of experience data should have been completed. This report was recently completed, of which this article is an abstract.

The fact that nearly all of the pitting of turbine runners occurs on the back or vacuum side of the bucket is significant. It suggests immediately the thought that the degree of vacuum or the draft head acting on the runner is in some way responsible for the pitting action.

### Draft Head the Principal Factor

The most striking case showing the effect of draft head on pitting was perhaps that given in the preliminary report, where two runners were installed on the same vertical shaft. The number of hours of service were identical, as were also the head, speed, gate opening and character of water. The only difference between the two was in elevation with respect to tailwater. The upper runner, which operated 24 ft. above tailwater, developed excessive pitting in five years of service, while the lower runner, which operated two feet below tailwater developed no pitting in ten years of service.

Two cases were cited where a lowering of the tailwater by about two feet made all the difference between excessive pitting and no pitting at all. Previously, the runner had been operated for twelve years without pitting. In the two years following lowering of the tailwater, however, the runner buckets pitted entirely through. The cases are cited here to show how a relatively small change of draft head in a particular installation may mean all the difference between no pitting at all and serious pitting. The amount of pitting does not increase as a straight line curve directly with the draft head, but at a certain critical point on the draft head scale it jumps from nothing to excessive pitting.

### Classifying the Turbine

In classifying the turbines as to their rates of pitting, it was recognized that high-head wheels are subjected to more severe mechanical action of the water than are the low-head wheels and that their runner buckets are not so massive in construction. Then, too, with the higher velocities that exist in the high-head wheels a given change of bucket contour has a greater effect than in a low-head wheel. For the purposes of classification a low head was considered to be less than 100 ft., a medium head to be between 100 and 400 ft. and a high head to be greater than 400 feet.

The wheels were assigned to the three classifications as to rate of pitting on the following basis which assumes no repairs: Class A. No Pitting—(1) Low-head wheels with a probable life greater than twenty years; (2) medium-head wheels with a probable life greater than sixteen years; (3) high-head wheels with a probable life greater than twelve years.

Class B, Moderate Pitting—(1) Low-head wheels with a probable life between ten and twenty years; (2) medium-head wheels with a probable life between eight and sixteen years; (3) high-head wheels with a probable life between six and twelve years.

Class C, Excessive Pitting—(1) Low-head wheels with a probable life less than ten years; (2) medium-head wheels with a probable life less than eight years; (3) high-head wheels with a probable life less than six years.

The wheels in each class were then arranged in three groups according to their size. Runners up to 48 in. in diameter were put first, then runners up to 96 in. in diameter, while all runners over 96 in. in diameter were put in the last group. This was done to show, if possible, whether or not there

AVERAGE TOTAL DRAFT HEADS

| Size of Wheels: Diameter in Inches | Class A, No Pitting | Class B, Moderate Pitting | Class C, Excessive Pitting |
|---|---|---|---|
| Up to 48 | 19.0 ft. | 24.9 ft. | 27.5 ft. |
| 48 to 96 | 16.2 ft. | 23.9 ft. | 25.9 ft. |
| Over 96 | 19.0 ft. | 20.6 ft. | 22.7 ft. |

is a definite tendency of the larger diameter wheels to pit at lower draft heads than the smaller runners. The foregoing classifications result in nine groups of wheels.

The figures in the table show how the average total draft head for the different groups decreases with an increase in the size of the wheel. This table may be considered a summary of the experience data received. It shows a definite decrease in the average limiting draft head toward the larger wheels.

The class B wheels are perhaps the best criterion for a determination of the critical draft heads at which pitting will occur, because these wheels are just on the border line. The averages of Class A and Class C wheels are not so significant because of the influence of wheels having extremely low draft heads included in the averages for Class A wheels, and of wheels having extremely high draft heads in Class C wheels.

### Effects of Draft Head

To better illustrate the effect of draft head on the pitting of turbine runners, the chart shown in the figure was prepared. On it are given the rate of pitting, total draft head and diameter of wheel for each turbine. This figure is similar to the one shown in the 1924 report. While at first glance the points appear to be widely scattered, a closer inspection shows them to be more consistent than might be expected in view of the character of the data and the omission from consideration of many variables, usually minor in effect, but which should nevertheless be included to obtain the true draft head on the runner blade.

While the line AA does average the points showing moderate pitting, it was not intended to establish a definite limit beyond which it is not safe to go in future designs. However, it will at least serve as a guide to operating companies installing turbines in the future. With careful runner designs and a better understanding of the causes of pitting than has been obtained in the past, it may be possible to exceed by several feet the draft heads corresponding to the line AA. It should be kept in mind that this line was drawn merely to show that the average wheel installed in the past has pitted when the total draft head has exceeded certain definite draft heads.

### Effect of Material on Pitting

The returns show that pitting is not confined to runners in either the high- or the low-head classes, or to high or low specific-speed wheels, or to runners having high specific speed with respect to head. Cast iron, cast steel, steel plate, bronze and monel metals all have developed pitting. There does, however, appear to be a definite advantage in the use of bronze for high-head wheels. However, this may be due to the possibility of obtaining smoother or more uniform castings rather than the resistance of the metal itself to corrosion.

It is believed that if one were able to figure the total draft head existing at every point on the surface of the runner buckets, it would be possible to deter-

mine absolutely whether or not pitting would occur. In the final analysis it is the total draft head existing on the runner bucket surface which determines whether or not pitting is to occur. From the many replies and experiences received, it has been proved beyond a doubt that pitting occurs in turbines where the main stream of water pulls away from the bucket surface. This occurs when the reduction of pressure tends to exceed the barometric limit and when the draft corresponding to the barometric limit is not sufficient to deflect the stream enough to keep it in contact with the runner surface. It can be seen from this that there are quite a number of factors that can effect pitting. Sharp curves, humps or depressions, or any irregularities in the bucket surface can, if of sufficient magnitude, produce pitting. Naturally, their effect is most conspicuous when the major factors involved in total draft head, namely, height of runner above tailwater and velocity at the throat of the runner, bring the draft head within, say, 10 ft. of the barometric limit. It is then that bucket irregularities and runner design have an important bearing on whether pitting will occur.

Part-gate operation or improper design can play an important rôle in building up the draft head within the runner.

A poorly designed wheel can be set with a low height above tailwater and show no pitting at all, while on the other hand a perfectly designed wheel may be set so high above tailwater as to make it impossible to avoid pitting. Slight modifications in the design of a wheel that shows moderate pitting can oftentimes correct the difficulty.

### Dissolved Oxygen the Active Agent

The experience of operating companies and recent studies in connection with the corrosion of metals would seem to indicate that dissolved oxygen is the active agent in the pitting process. Wherever the main stream of water pulls away from the bucket surface, there is an opportunity for oxygen to be drawn from the passing stream of water, the oxygen being released by the draft head and becoming highly concentrated in the violent eddies set up. Water comes into a turbine containing the full amount of dissolved oxygen corresponding to atmospheric pressure. In passing through the turbine, the pressure is suddenly reduced to less than atmospheric, with the result that minute bubbles of oxygen probably appear in the water in a manner not unlike the way water from a faucet will sometimes appear milky when drawn in a glass. This milky appearance is due to the minute bubbles of air which are released when the pressure is suddenly reduced to atmospheric. It sometimes takes a minute for all the bubbles to disappear.

Where the passages in the runner are completely filled with water, these minute bubbles are swept along into the draft tube and do not have an opportunity to accomplish their destructive work, but where a vacuous space exists there is an opportunity for oxygen to become highly concentrated from the continual drawing of oxygen from the passing stream. In these vacuous spaces, no doubt, there are violent eddies which are sufficient to sweep away the products of corrosion and keep the metal surface bright and exposed to further chemical or electrochemical action.

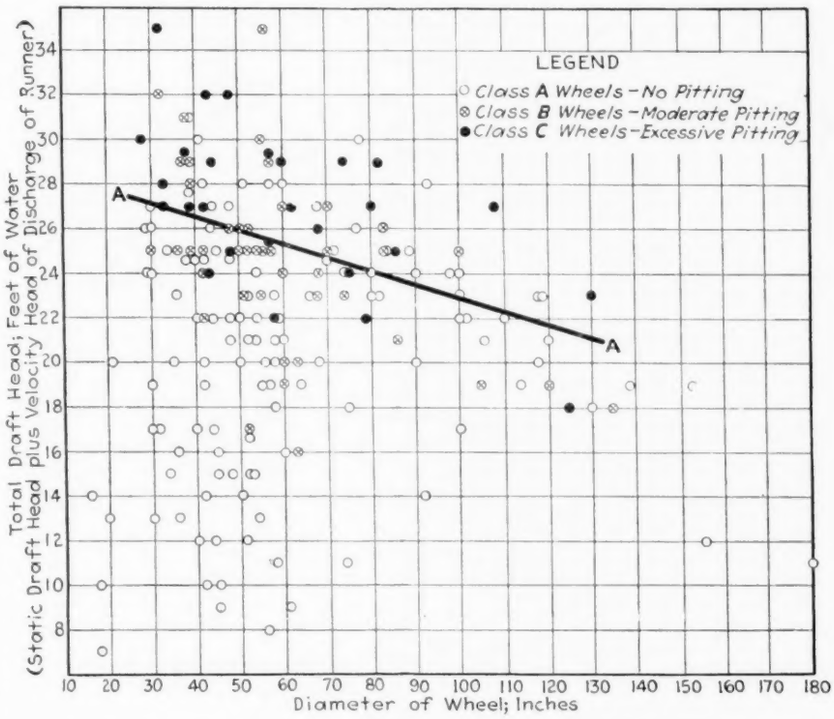
At a temperature of 60 deg. F., water that is exposed to the atmosphere will contain normally about 6.9 c.c. of oxygen per liter. If the temperature is kept the same and the pressure reduced to that of a perfect vacuum, the oxygen content of the water will be reduced in practically direct proportion to a zero oxygen content at zero absolute pressure. In other words, all the oxygen will have been released by the change in pressure from atmospheric to a complete vacuum.

Pitting may be avoided by a lower wheel setting or by any other method that reduces the draft head at the point where pitting occurs. There have been several cases where this draft head has been reduced by means of admitting air into the draft tube. This method, however, in many cases at least, probably reduces the efficiency of the unit and should be considered only as a means of remedying an improper original design. The draft head may be reduced by cutting down the load carried by the wheel to a more efficient gate opening. There were many cases of pitting where wheels had been overgated in order to secure the increase of power that such operation afforded. The importance of a thorough understanding by operating companies of the factors that govern pitting cannot be overestimated.

### Methods of Prevention and Repair

Pitting on existing runners may be minimized by building up the affected areas by the electric arc welding process, using a metal that resists corrosion better than the original metal. The electric-arc welding seems to be the most successful one yet developed. The oxyacetylene welding process has not proved entirely satisfactory so far, in the experience of operating companies. The chief difficulty seems to be in getting uniform heat and in preventing shrinkage cracks.

Only one company reported having welded bronze runners by the oxyacetylene process with any degree of success. This company preheats the runner in a brick enclosure by means of a gas jet, to a uniform cherry red. The welding is then carried on without interruption at this temperature until completed. Finally, the runner is allowed to cool very gradually. This method was found to be the only one that would avoid fractures.




*Shows effect of draft head on pitting of turbine runner*

There have been, however, a number of successful pieces of electric arc welding work, especially on cast-iron and steel runners. The art of doing this work has been greatly improved in the last two or three years. By using the right kind of electrodes, it is possible to weld large cast-iron runners in place, depositing the metal in an overhead position.

The usual procedure is first to chip out the pitted areas, taking care to leave good square edges; second, to drill and tap the parent metal for ½-in. studs spaced about 3-in. on centers; and third, to build up the area to the original bucket contour by depositing a metal that resists pitting better than the parent metal. In some cases, as the layers of metal are deposited, a peening hammer is used to relieve such stresses as may have occurred from temperature changes. In the most recent work the welded areas have been built up to a full contour and then ground to a smooth finish. While it is not believed to be absolutely essential to grind the surface to a finish,

especially in large low-head wheels, it is important to grind down any irregular contours so that there will not be any possibility of deflecting the main stream of water passing over the weld. Some companies have used in the bottom part of the weld a metal that bonds more perfectly with the parent metal, rather than a metal that has the greatest resistance to pitting. Then on the outer layers of the welding they have used a metal whose primary value lies in its resistance to pitting.

Many metals have been tried out, but so far it appears that steel with a high percentage of carbon and manganese offers more resistance to pitting than a pure iron, such as Armco. Steels containing ¼ per cent of copper also show up very well. Various kinds of cements, paints and metal spraying processes have been tried out, but with scant success. They are usually too porous and lack sufficient mechanical strength to stand up for any length of time. Of these metals neat cement seems to last the longest, but its use is not to be compared with the electric arc welding process.

In two cases reported, type metal has been deposited in the pitted areas, but in one of the cases resistance to pitting was only about 50 per cent as effective as was the electric-arc welding on adjacent vanes of the same wheel. The other company reports fairly good results from the use of type metal in view of its relatively low cost of application, although the metal has not been in place long enough as yet to draw definite conclusions. It is understood also that some of the manufacturers have experimented with the use of rubber in this connection. The degree of its success is however, not known.

### Removable Pitting Plates

It should be pointed out that some of the manufacturers have recently furnished runners with removable pitting plates. These plates are placed in the portions of the runner where pitting may occur if the draft head becomes excessive. This arrangement makes it possible to repair a unit very cheaply if pitting occurs.

A number of companies have tried the experiment of drilling holes through the runner vanes from the pressure side to the vacuum side in the region where pitting has occurred, with the idea of relieving the vacuum on the lower side of the bucket. After trying out such an experiment over a period of two years one of the companies stated it had not arrived at any definite conclusions as to the value of the experiment. Other companies have, however, spoken quite emphatically concerning the merits of of this experiment. In the absence, however, of definite statistics on this point, the effectiveness of this experiment is questioned. It is felt that if the holes are large enough to be of value in relieving the vacuum on the underside of the buckets, a definite loss of efficiency will result. Then, too, it is felt that any reduction of the vacuum will increase the tendency of the water to pull away from the runner surface and increase the area of pitting. This statement is made, however, without evidence one way or the other, and should be considered as suggestive only, until more data are available.

# Constantly Improving Boiler Room Efficiency at Hell Gate*

By H. W. Leitch
General Superintendent of Power Plants, United Electric Light & Power Co.

The author describes successive additions to the boiler room of the Hell Gate Station, whose extensions have been made at fairly regular intervals, and shows the effect of those additions on efficiency and maintenance. He describes the four groups of boilers installed beginning in 1921 and ending in 1925, pointing out the growth in stoker length and the evolution of boiler design from the original type with interdeck superheaters to the later types employing water-cooled walls with a smaller boiler and with superheater and economizer.

It is evident that much development work has been done. Later installations are simpler in design and construction, and their efficiency is better than that of earlier units. The accompanying table exhibits some of the characteristic features of these four boiler installations.

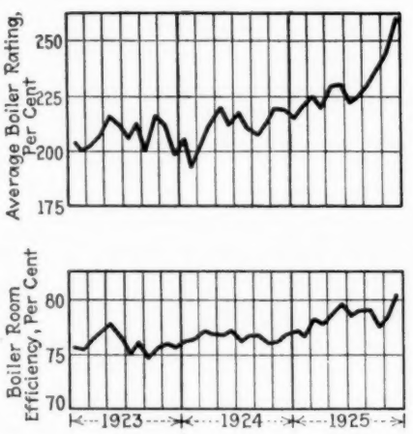



*Fig. 1—New equipment gives increased boiler room efficiency despite higher average boiler rating*

With the aid of curves the author shows a reduction of almost 50 per cent in boiler and setting maintenance. The brickwork maintenance is reduced about 54 per cent and the stoker maintenance about 32 per cent. The reduction in brickwork maintenance has been due to the installation of water-cooled walls, and the reduction in stoker maintenance to the increased length of stoker with the accompanying improvement in air distribution, with better distribution of combustion and less severe action on the stoker parts. Improvements in the mechanical design of stokers have also made it less expensive to replace damaged members.

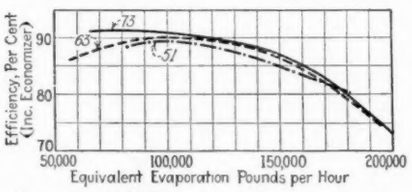



*Fig. 2—Efficiency of the new boiler units is better than that of the older equipment*

The lower curve of Fig. 1 shows the increasing boiler-room efficiency obtained in spite of the increased average rating shown by the upper curve. The increase in efficiency is the result of the improved efficiency of the new units, as shown in Fig. 2. Still higher efficiencies would undoubtedly be attainable, except that because of clinker difficulties it has been necessary to sacrifice some grate area in order to increase the capacity of the ash-disposal mechanism.

After presenting the results of a test of one of the recently installed boilers, the author points out that under test conditions these units run as high as 94 per cent of the efficiency theoretically available with a perfect boiler, superheater and furnace. He concludes that it is questionable whether any considerable investment to improve this best point efficiency is warranted. There remain, however, three important goals —to make the operating efficiency equal the test efficiency, to increase the range of high efficiency to accommodate practical conditions of load variation and eliminate the banking loss, and to reduce the investment by increasing the overload capacity of the evaporating surfaces and coal-burning equipment by reducing furnace volume, and by more skillful design and arrangement of apparatus.

*Abstract of paper presented at the Providence, R. I., meeting of the A.S.M.E., May 5, 1926.

HELL GATE BOILER INSTALLATIONS

| Year | 1921–22 | 1923–24 | 1924–25 | 1925–26 |
|---|---|---|---|---|
| Boilers | | | | |
| Number | 12 | 3 | 3 | 3 |
| Tubes wide | 54 | 54 | 54 | 54 |
| Tubes high | 20 | 16 | 12 | 12 |
| Surface, sq.ft | 18,900 | 15,500 | 12,100 | 12,100 |
| Water-cooled side walls | | | | |
| Surface, sq.ft | 0 | 400 | 460 | 460 |
| Superheaters | | | | |
| Surface, sq.ft | 2,135 | 7,410 | 10,450 | 4,000 |
| Location | Interdeck | Top of 1st Pass | | |
| Economizers | | | | |
| Surface, sq.ft | 0 | 13,824 | 12,100 | 10,692 |
| Stokers | | | | |
| Number per boiler | 2 | 1 | 1 | 1 |
| Retorts per stoker | 14 | 14 | 14 | 14 |
| Tuyeres long | 17 | 33 | 33 | 33 |
| Grate area, sq.ft | 472 | 378 | 378 | 378 |
| Furnace volume, cu.ft | 8,000 | 6,500 | 6,500 | 6,500 |
| Ratio of total water heating surface to grate area | 40 | 42.1 | 33.3 | 33.3 |
| Ratio of furnace to total water heating surface | 0.423 | 0.41 | 0.517 | 0.517 |
| Ratio of furnace volume to projected grate area | 16.9 | 17.2 | 17.2 | 17.2 |
| Ratio of superheating surface to total water-heating surface | 0.113 | 0.478 | 0.466 | 0.317 |
| Ratio of economizer surface to total water-heating surface | 0 | 0.893 | 0.87 | 0.85 |

# Low-Temperature Carbonization*

By DAVID BROWNLIE

FOR over 75 years past inventors have endeavored to treat coal by methods involving carbonization so as to obtain the maximum yield of liquid products, although what is generally termed low-temperature carbonization for the specific purpose of the production of a hard free-burning smokeless fuel, can be said to have started with Thomas Parker in 1890. Today there are well over 100 processes, represented by hundreds of patents, that come within the scope of low-temperature carbonization. One of the great difficulties is to bring together and classify the vast amount of information available, and in the paper the author dealt more or less fully with one section of low-temperature carbonization only; that is, processes for the production of a hard free-burning smokeless fuel which involve the actual mechanical compression or briquetting of the charge before or during carbonization.

### Would Help British Mines

The whole subject is of vital importance to the British colliery industry. The net cost of the process plants, etc., spread out among all the collieries in the country, would be a small matter compared with the advantages to the whole industry, and sooner or later Great Britain will be forced to treat her raw coal on scientific lines.

It has been well-known that methods of low-temperature carbonization involving compression or briquetting of the charge give a free-burning smokeless fuel because of structure, even when the volatile content is less than 3 per cent, just as charcoal is free burning because it is built up of small cells with free cell walls. Other early workers in this field whose memory today has been forgotten, include James Palmer Budd, of the Ystalyfera Iron Works, Swansea, who carried out coal blending in 1850 on the most modern principles, Joseph Souquiere, of Paris, 1859, blending coal with coke breeze, and John Bethell, of Llanelly, 1854, in connection with the carbonization of a blend of non-coking coals with pitch.

### Mechanical Compression System

With respect to the compression of the viscous charge during actual carbonization to give a hard and close-grained fuel, work in this field dates back to about 1870, and Professor Parr first studied the principle in detail. Allied to this is L. L. Summers' continuous coking process of New York in which the charge travels through a long narrow firebrick oven by means of a reciprocating iron floor with a projecting fin at one end, the charge being subjected to very considerable compression. The modern work in this field for strictly low-temperature carbonization is based on the investigations of Franz Fischer and includes in the first place the process of Otto Dobbelstein, of Essen. This consists of the mechanically continuous production of hard smokeless low-temperature fuel with carbonization at about 1022 deg. F. for four hours, using a special horizontal cylindrical retort built up of alternate transverse thin steel cells and heating chambers with a loose internal roller ram feed and compression of the charge.

### Novel German Process

Equally remarkable is the process of E. Raffloer, of Duisberg, Germany, covering the mechanically continuous production of hard smokeless low-temperature fuel with carbonization at about 842 deg. F. for one hour, using a special horizontal cylindrical retort externally heated and divided inside into a series of long parallel narrow channels, or gutters, filled with the charge, operated with reciprocating rams and also having a loose heavy roller for compression.

In the Meguin A. G. process of Butzbach, Germany, two concentric vertical retorts are used, rotating at relatively high speeds so that the viscous charge is compressed up against the inner surface of the outer cylinder by centrifugal force.

### Use of Pitch for Binder

Low-temperature processes depending on the carbonization of briquets made in the ordinary way with pitch, have been investigated for many years past and one of the best-known processes is the "Smith Carbocoal," which was operated between 1920 and 1922 on a very large scale at South Clinchfield Va., at one time attaining an output of 600 tons per 24 hours. The plant, however, was closed down and the process is now being thoroughly investigated by Charles V. McIntire, of New York. It consists essentially in carbonizing for 2½ to 3 hours bituminous or semi-bituminous coal under low-temperature conditions of 1,200 to 1,400 deg. F. in an externally heated horizontal retort having an internal-screw conveyor. The low-temperature fuel is then briquetted with pitch and the briquets carbonized in a high-temperature retort of the externally heated, intermittent, inclined firebrick type, for 8 hours at a temperature of approximately 1,800 deg. F.

The process of the Midland Coal Products, Ltd., of Netherfield, Nottingham, Eng., consists in briquetting small non-coking coals, generally blended with about 30 per cent of coking coal, with pitch as usual. The pitch briquets are carbonized in a continuous vertical retort, using a blast of steam and air at the bottom to gasify the charge partly, the duration of travel being 5 hours and the maximum temperature zone about 2,200 deg. F.

As regards the third method, that of carbonizing briquets without any pitch, the best-known process is the invention of E. R. Sutcliffe, which is controlled by Sutcliffe Speakman & Co., Ltd., of Leigh, Eng. A plant of 100 tons per 24 hours is almost completed at Leigh, the process depending essentially on briquetting the coal without any binder at high pressures, up to 10 tons per square inch in a new type of briquet press. The briquets are then carbonized in a vertical continuous retort internally heated, generally at a maximum of about 1,600 to 1,850 deg. F. by means of a stream of inert gas and steam, the carbonized briquets being taken out at the bottom after heating for 6 to 8 hours. The fuel is entirely free-burning, although containing only about 3 per cent volatile matter and the oils obtained, 14 to 20 gal. per ton, are of low-temperature composition.

### Eliminating the Binder

A very remarkable new process, is that of Dr. Rudolf Delkeskamp, of Berlin, by which it is claimed that coal or any other carbonaceous material can be briquetted without any binder, merely using the ordinary simple type of briquet press at one ton per sq.in. instead of at abnormally high pressure. The principle is entirely novel and uses as a binder part of the coal itself, which is ground up with water to a colloidal condition and then mixed in with the bulk of the coal. The resulting briquets are then carbonized direct without expansion or other troubles, either at low temperature to give a smokeless free-burning fuel or at high temperatures to give a coke, which is claimed to be much superior to ordinary coke. Any carbonaceous material can be used as the colloidal binder; bituminous, semi-bituminous, and anthracite coal, canneloid refuse, brown coal, lignite and peat can all be converted into hard briquets by mixing them with any carbonaceous material, blended or otherwise, in a colloidal condition.

*Abstract of paper read before the South Wales Institute of Engineers, Park Place, Cardiff, April, 1926.

## Southeastern Output Shows Substantial Gain

The Southeastern Power and Light and Associated Gas groups recently reported increased electrical power outputs.

The Alabama Power Co., Georgia Railway & Power Co., Mississippi Power Co. and Gulf Electric Co., which serve the industrial sections of Alabama, Georgia, West Florida and Mississippi, reported an output of 143,114,946 kw.-hr. in May, an increase of 25 per cent over May, 1925. Output of these companies in the year ended May 31 was 1,697,660,850 kw.-hr. The Associated Gas & Electric Co. reported an increase of 16 per cent in May output compared with May, 1925, and of 22½ per cent in the year ended May 31 iompared with the previous year. Output in the 1926 period totaled 686,000,000 kilowatt-hours.

# News in the Field of Power

## Plan to Check Erosion of Niagara Falls

Concerted efforts toward the prevention of the gradual destruction of Niagara Falls, due to the steady erosive action which for a long period has been eating away the escarpment at the amazing rate of seven feet a year, is the chief aim of negotiations recently completed between the American and Canadian governments arranged for a joint engineering inquiry into methods of correction, Secretary Hoover has announced.

To preserve Niagara as a scenic spectacle, and at the same time to provide water for commercial needs, is the double purpose of the undertaking.

The announcement of Secretary Hoover states that "of late years a break has developed in the escarpment at the center of the Horseshoe Falls, creating a V-shaped notch into which an increasing volume of water is concentrating, thereby impoverishing the flow of water over the two wings of the Falls and greatly lessening their magnificent scenic effect. This notch in recent years has broken down at the rate of over 7 ft. per annum."

### Public Questions Involved

The work of preparing the report is to be placed in the hands of the existing Niagara Board of Control, consisting of Major DeWitt C. Jones, district engineer, U. S. Army, at Buffalo, and J. T. Johnson, the Canadian representative. This board is to be supplemented for the purpose of this study by two other members who "shall have special regard for the large public questions involved in such steps as may be taken to save the Falls." These members are J. Horace McFarland, former president of the American Civic Association, U. S. representative, and Dr. Charles Camsell, deputy minister of mines and chief of the Geological Survey of Canada, the Canadian representative. Before the board begins its sittings, two engineers representing each country are to meet and formulate detailed instructions for it. The board's authority extends only to the preparation of an engineering report and recommendations.

### Small Islands Proposed

Secretary Hoover stated further that: "At the insistence of the Canadian authorities the Board will also report on the possibilities of further diversion of water for power purposes provided the engineering work contemplated demonstrates that it can be accomplished without any loss of scenic values. As president of the American Civic Association Mr. McFarland has long been a leader in the movement to protect Niagara, and his appointment has been made as public assurance that the scenic value of the Falls is the first consideration.

"It has long been the opinion of competent engineers that this situation could be remedied. One plan suggested has been the construction of small islands at a point above the notch in order to divert the water and spread it over the wings of the Falls."

## L. A. Osborne Made Chairman of Industrial Board

Loyall A. Osborne, president of the Westinghouse Electric International Co., was signally honored recently when he was elected chairman of the National Industrial Conference Board at the tenth annual meeting of that organization held in New York City.

In accepting this office, Mr. Osborne assumes the chairmanship of a body whose members are the delegates of 27 national and state industrial organizations and four government departments, comprising more than 50,000 manufacturing concerns which employ a total of more than 7,000,000 men and women. The board maintains a large staff of economists, statisticians and engineers who are continually investigating domestic and foreign problems of economic-industrial interest. Since its organization in 1916 it has issued 115 research and 35 special reports and many monographs on subjects of timely and practical concern.

Mr. Osborne, who is a graduate of Cornell University, '91, joined the Westinghouse organization immediately upon leaving college, and was made vice-president of the Westinghouse Electric & Manufacturing Co. in 1902. He is now senior vice-president of that organization. During the war he was a member of the Council of National Defense, a member of the War Labor Planning Commission and of the War Labor Board. He succeeds Frederick P. Fish, of Fish, Richardson & Neave, Boston, as chairman of the Conference Board.

## Indiana Electric Companies In Combine

Merger of the Northern Indiana Gas and Electric Co. into the Northern Indiana Public Service Co. became effective today with the filing of the merger agreement with the secretary of state at Indianapolis and with the recorders of the twenty-five counties in which the company will operate.

The new company, controlled by the Insull interests, will serve 119 communities with gas or electrieity, or both, including South Bend, Fort Wayne, Lafayette, Michigan City, Logansport, Hammond, East Chicago, Whiting, Elkhart, Valparaiso, Plymouth, Crawfordsville, Frankfort and Wabash.

## Clarence V. Kellogg, Leader in Boiler Field, Dies

Clarence V. Kellogg, a past-president of the American Boiler Manufacturers and president of the Kellogg-Mackay Co., Chicago, died suddenly at his home, 1338 Fargo Avenue, in that city, at 4 a.m., Sunday, May 9. Although he had had a slight heart attack last February, he was apparently in good health, and his sudden death was a shock to his friends.

Mr. Kellogg was born in Cicero, N. Y., Jan. 19, 1860. He attended the local grammar school, supplemented later with an academic education. Up to the age of eighteen he worked on his father's farm, developing a physical strength which carried him through many years of an unusually active business life. His first outside employment was with a tea store in Syracuse, N. Y., but after a brief experience in the tea business, he began the study of law, and was admitted to the bar in Syracuse in 1881. He continued his law practice in New York State, making commercial law his specialty until Feb. 1, 1893.

Tiring of law as a vocation, he went to Chicago in 1893 as the treasurer of the American Boiler Co. In 1898 the company was succeeded by the Kellogg-Mackay-Cameron Co. The Pierce, Butler & Pierce Manufacturing Co. took over the Eastern business of the American Boiler Co., buying up the entire capital stock and selling to Mr. Kellogg the Western end of the business. The Kellogg-Mackay-Cameron Co. continued until Jan. 1, 1909, when Mr. Cameron retired and the concern became the Kellogg-Mackay Co.

Aside from his regular business connections Mr. Kellogg was active in other companies. His interest in trade associations was unusually strong. He was president of the Central Supply Association from 1913 to 1916, an honor never before or since duplicated. At one time he was president of the National Tubular Boiler Co., and also the Illinois and Wisconsin Jobbers' Credit Bureau. For some time he was vice-president of the Pierce, Butler & Pierce Manufacturing Corp., and a director of the Kewanee Boiler Co. He also had been president of the American Boiler Manufacturers' Association and was a member of the National Pipe & Supplies Association.

Mr. Kellogg, a 32nd degree Mason, was active in club and fraternal circles, and belonged to the following organizations: The Chicago Athletic Association; Park Lodge, No. 843, A. F. & A. M.; Park Chapter No. 213, R. A. M.; Oriental consistory, Medinah temple; Medinah Country Club, and Briergate Golf Club. He is survived by his widow and one son, Clarence V., Jr. He was buried in Rose Hill Cemetery, Chicago, May 12.

## Charles E. Giles, Corliss Engine Builder, Dies

Charles E. Giles, consulting engineer and one of the close associates of the late George H. Corliss of steam engine fame, died at his home in Providence, R. I., on May 9, 1926. In spite of his eighty-three years Mr. Giles had been active in his profession up to within ten days of his death.

Mr. Giles was born at Boothbay, Me., on Oct. 14, 1843, and after attending the public schools he served as carpenter's apprentice under his father, who was a building contractor. On July 22, 1862, Mr. Giles enlisted as a private in Company E, Fourth Maine Volunteer Infantry. Almost immediately he found himself in the second battle of Bull Run. From that time until the close of the war he participated in at least fifteen battles, including Gettysburg, the Wilderness, Spottsylvania, Cold Harbor, and the siege of Petersburg. He was twice wounded and was present at the surrender at Appomattox.

In 1879 Mr. Giles became associated with George H. Corliss as foreman of the pattern shop at the Corliss Steam Engine Co., later becoming general superintendent and a director of the company. Following Mr. Corliss' death in 1888, Mr. Giles carried on the works until their sale two years later to the American & British Mfg. Co. He then served many years as agent of this latter concern.

Mr. Giles in 1900 designed and built the largest Corliss type engine ever constructed, this being still in daily operation in the Albany Street power plant of the Boston Elevated. He also installed the first steam turbines in manufacturing plants both in Rhode Island and Massachusetts.

Mr. Giles was a Mason, and was also one of the last of the A.S.M.E. members who was also a member of the Grand Army of the Republic. He joined the A.S.M.E. in 1891.

## A. E. Fitkin Merges Power Concerns in Southwest

Consolidation of twenty-four public utility properties of the Fitkin system, situated in Kansas, Michigan, Missouri, Arkansas and Texas, and having a value of more than $17,806,000, was announced yesterday by A. E. Fitkin & Co., managers of the plan according to report published in the *New York Herald Tribune*, June 10. The properties are now grouped under the Commonwealth Light & Power Co. and the Interstate Electric Corp.

The new company will be known as the Inland Power & Light Corp. and upon completion of the merger new properties purchased, or under option for purchase, will be added to the corporation. All the common stock of the subsidiary companies is to be owned directly or indirectly by the Inland Power & Light Corp. The boards of directors of the Commonwealth Light & Power Co., of the Interstate Electric Corp. and of the Tide Water Power Co., and A. E. Fitkin & Co., managers, have approved the plan. The merger starts with an annual business of $10,000,000.

## Idealism In Engineering—Plea of Pupin at M. I. T.

Degrees were awarded to 637 candidates at graduation exercises at the Massachusetts Institute of Technology on June 8. Following the custom of other years, the ceremonies were held in the open air in Du Pont Court. Nearly 3,000 guests, relatives and friends of the seniors, were gathered in the court when the academic procession marched from the main building through the Great Court.

Michael I. Pupin, director of the Phoenix Research Laboratories at Columbia University and president of the American Institute of Electrical Engineers, making the commencement address emphasized the increasing religious and esthetic values that are being fostered through the developments in natural science, and appealed especially for a "scientific idealism" which would properly co-ordinate these discoveries.

"There was a time when we were too busy with the solution of purely material problems to devote much attention to the cultivation of scientific idealism, but the growth of American universities, with their splendid research laboratories, managed by men devoted to scientific idealism, was the first manifestation of the American renaissance."

## Lake States In Water Diversion Row

At its final session of the term on June 7 the United States Supreme Court granted a motion to file answers in the suit of Michigan against Illinois, involving diversion of Lake Michigan waters through the Chicago sanitary canal. At the same time the Court denied without prejudice a motion to consolidate this case with the suit of Wisconsin against Illinois which involves the same primary question.

Several other lake states have intervened in the Michigan suit as co-plaintiffs. Both suits are directed against the action of Illinois, through the Chicago Sanitary District, in diverting any water from Lake Michigan.

## Hodgkinson Appointed Consulting Expert for Westinghouse Electric

Slightly more than a year after he was awarded the Elliot Cresson Gold Medal by the Franklin Institute in recognition of his scientific achievements, Francis Hodgkinson, for many years chief engineer of the South Philadelphia Works, Westinghouse Electric & Manufacturing Co., was appointed consulting mechanical engineer for the organization as a whole.

An official announcement of this was issued here and signed jointly by H. T. Herr, vice-president in charge of the South Philadelphia Works, and W. S. Rugg, vice-president in charge of engineering.

With the duties and responsibilities of Mr. Hodgkinson broadened according to the new arrangement, his great knowledge, which has earned fame for him both in this country and abroad, will be made available to all of the operations of the company. His prime duty will be that of consulting engineer in all design problems and other engineering activities at South Philadelphia.

In addition, however, Mr. Hodgkinson will contribute his effort in a consulting capacity on any mechanical problems arising under the necessities of the company at any other location. Likewise he, when required, will assist the sales department in the presentation of engineering subjects and be available in the same capacity to the Westinghouse Electric International Co., continuously engaged in engineering problems in many different foreign countries.

*Francis Hodgkinson*

## Illinois State N.A.S.E. Convenes

The Illinois State Association of the National Association of Stationary Engineers held its twenty-second annual meeting at Decatur, Ill., from June 2 to 4. Exhibits and the business sessions were provided for by the convention committee, headed by W. H. Jennings, state president.

Of the routine business conducted, Secretary Jacobsen reported finances to be in a satisfactory condition and Einor Winholt, state deputy, reported slight losses of membership in six of the seven locals belonging to the state organization. To arouse interest in the new educational plan, the merit system, the state body appropriated funds to present a course to each of the seven locals. Minor changes in the constitution were made to permit holding a joint meeting the coming year with the Iowa State Association.

Educational work at the convention consisted of the presentation by C. A. Crytser, No. 28, Chicago, of the new General Electric reels.

## New England To Consider Power Problems

The next quarterly meeting of the New England Council, representing many agricultural, industrial and commercial organizations in the six New England States, will be held on Friday, June 11, at Burlington, Vt. One of the subjects announced for consideration is power, the objectives adopted by the council being thus stated: (1) The most economical distribution of power throughout New England at the lowest possible rates consistent with good service; (2) maximum utilization of all water powers and interconnections for economy and protection of all interests; (3) reasonable regulation that will adequately protect the public interest and permit and encourgae the healthy growth of the industry.

## Ohio Power Companies Seek Merger

Plans for merging more than $10,000,000 worth of electrical properties in various sections of Ohio with the Ohio Power Co. of Canton, were made public when application was made to the State Utilities Commission.

The Ohio Power Co. also asked authority of the commission to issue $12,000,000 bonds and stock to pay for the new properties. The largest single unit to be acquired by the Ohio Power Co. is the Ohio Service Co., of Coshocton, whose properties are valued at $5,589,281, for which cash is to be paid.

## International Paper Co. to Expand Gatineau Project

It is announced that the International Paper Co. plans further expansion of its power-development program on the Gatineau River in the province of Quebec, by the development of Nigger Rapids in the Maniwaki district, about 100 miles from the site of the power developments at Chelsea. Surveys of the Nigger Rapids area are now being made.

## Russian Hydro-Electric Men On Visit Tell of Projects

Josef A. Tzichevsky, chairman of the Russian Commission making a survey of the principal power industries in Pittsburgh recently, accompanied by Boris K. Victorhoff, another member of the commission, and H. H. Kalantar, of the Amtorg Trading Corp., visited the East Pittsburgh works of the Westinghouse Electric & Manufacturing Co., West Penn Power Plant at Springdale, Pa., and the Duquesne Light Co.'s plant at Colfax, Pa.

The representatives of the United Soviet Socialist Republic said that the proposed hydro-electric development in Russia for which $75,000,000 is being expended and which is the occasion for their tour of the states, will extend from the Black Sea to the northern part of Russia.

In addition to the development of power resources, wide irrigation is planned.

## Austria Rapidly Develops Hydro-Electric Power

Increase in the hydro-electric development of Austria during recent years is shown by the fact that, while in 1918, when Austria became a republic, hydro-electric development in that country totaled only 170,000 hp., at the end of 1925 it had increased by 253 per cent to 431,000 hp., according to advices to the Department of Commerce from Assistant Commercial Attache Elbert Baldwin, at Vienna.

Some fifteen stations totaling 96,400 hp. were still under construction in 1925. It is expected in Austria that three of these stations will be completed in 1926. New construction to be begun in 1926 includes seven stations totaling 13,900 hp. In this development from 1918 to 1925 th eAustrian Federal Railways participated to the extent of 10 per cent of the horsepower developed, the various hydro-electric power companies 70 per cent and plants owned and operated by industrial enterprises 20 per cent.

## New Japanese Plant In Construction

Construction of the first of four large factory units of a $2,000,000 industrial plant program of the Nippon Electric Co. at Tokio, Japan, has been started by the H. K. Ferguson Co. of Cleveland, Ohio, according to announcement by R. E. J. Summers, chief engineer.

The program contemplates the eventual replacement of all the old structures of the Nippon company by modern three- and four-story plants. The structures are to be erected with special earthquake resisting properties and more than 1,500 tons of steel will be use in the first unit.

The great bulk of the Nippon company's plants, which covered more than 4,500,000 sq.ft. of floor space, was destroyed during the earthquake of 1923. The Nippon Electric Co. is affiliated with the International Standard Electric Co., of New York, and prior to last September was the Japanese branch of the Western Electric Co.

## Three Water Power Designs Reported Favorably

A favorable report has been submitted to the Federal Power Commission by the Chief of Engineers on the power project of George B. McCleary on the Rock River at Grand Detour and at Latham. It is planned to develop 6,000 primary horsepower, but equipment sufficient to develop 12,000 hp. will be installed.

The Illinois Northern Utilities Company also is planning a development at Byron, Ill., on the same river, where 1,700 primary horsepower can be developed. The company plans to install 4,500 hp. The Chief of Engineers also reported favorably on this project.

The town of Highlands, N. C., has applied for a license to cover a small project on the Cullasagee River. It is desired to take advantage of the 300 hp. of primary power available at Highlands to supplement the power available for public utility use.

## New Brunswick Tidal Power Bill Ratified

The Canadian Parliament has finally passed the bill incorporating the Canadian Dexter P. Cooper Co., which proposes to develop electric power from the tidal waters of Passamaquoddy Bay between New Brunswick and Maine.

It was stated in the House of Commons that all Canadian interests had been safeguarded and that three departments of the government, as well as the International Joint Commission, had been given control over the operations of the company.

## Transmission Line To Cross Shenandoah National Park

The Shenandoah River Power Co., of Harrisonburg, Va., has applied to the Federal Power Commission for a license to cover a transmission line to traverse the Shenandoah National Park.

## Obituary

**Thomas H. Fritts**, well known in public-utility circles in Nebraska, died May 29 in Oakland, Neb., in his fifty-fifth year. Mr. Fritts had been in poor health for some time and had not been active in business affairs for the last three years.

He had formerly been an official of the Grand Island, Neb., central-station company for more than thirteen years and served twice as president of the Nebraska Section of the National Electric Light Association.

## Personal Mention

**James W. Armour** has been elected to the board of directors of the Riley Stoker Corp., Worcester, Mass.

**John H. Carter**, electrical engineer, is now with the Servel Corporation, manufacturers of electric refrigerators, 51 East 42nd Street, New York City.

**Col. James W. Fuller,** now has his headquarters at the offices of the Fuller Company, Catasauqua, Pa.

**G. W. Akerlou** has accepted a position with the Western United Gas & Electric Co. to take charge of their newly organized industrial gas engineering department.

**Edward G. Lee,** formerly chief designing engineer with the Central Maine Power Co., has joined the organization of Stone & Webster, Inc., Boston, Mass., as an engineer in the hydraulic division.

**William Paul Gerhard,** consulting engineer, of Scarsdale, N. Y., has been invited to be a member of the jury of awards at the Sesquicentennial International Exposition of Philadelphia, Pa.

**Roscoe Seybold,** electrical engineer with the Westinghouse Electric and Manufacturing Co., has been appointed assistant to F. A. Merrick, vice-president and general manager of the company.

**Morgan B. Smith,** chairman of the Detroit Section, A.S.M.E., has resigned as purchasing engineer for the Detroit Edison Co., to become member-at-large of the Works Manager's Committee, Power Division, of the General Motors Corp. at Detroit.

**A. D. Hunt,** for several years a member of the engineering staffs of the Westinghouse Electric & Manufacturing Co., has been appointed to the new position of manager of engineering. Hitherto Mr. Hunt has served in the position of manager of steam service at the works of the company in Philadelphia.

## Business Notes

**The Fuller-Lehigh Co.** announces that E. J. Billings has resigned from the Henry L. Doherty Co. to become vice-president in charge of sales for the Fuller-Lehigh Co., and will assume his new duties July 1, at Fullerton, Pa.

**The East Kootenay Power Co.** announces the immediate construction of an auxiliary steam plant at a cost of $1,000,000, to meet the electrical demands of the Elk Valley and vicinity. The company already possesses hydroelectric plants at Elko and Bull River, B. C., from which it supplies power to Kimberley, Cranbrook, Coal Creek, Fernie, and the collieries of the Crows Nest Pass.

**The Harris Crankless Diesel Engine Co., Inc.,** 1 Hunterspoint Avenue, Long Island City, announce that after the official test, scheduled for June 10th, the company will be prepared to offer manufacturers' rights to engine builders throughout the country to construct Crankless Diesel Engines for use in railway locomotives, steamships and yachts and for stationary uses in connection with industrial plants and public utilities. This company is the syndicate recently formed to handle the engines of the Crankless Engine Company of America and as such it holds contracts as the exclusive manufacturers and producers of this engine.

**The Wilson-Synder Manufacturing Co.,** makers of pumping machinery, of Pittsburgh, Pa., announce the appointment as representative of G. W. Walton with headquarters at 1605 Kirby Building, Dallas, Texas.

## Coming Conventions

**American Institute of Electrical Engineers.** F. L. Hutchinson, 29 West 39th St., New York City. Annual convention at White Sulphur Springs, W. Va., June 21-25.

**American Society for Testing Materials.** C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

**American Society of Mechanical Engineers.** Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

**National Association of Stationary Engineers.** F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state associations are scheduled for the following dates:

**New England States Association.** Freeman L. Tyler, 32 Briggs St., Taunton, Mass. Convention at New Bedford, Mass., June 16-19; **Ohio State Association.** T. S. Garrett, 2622 E. Second St., Dayton, Ohio, Convention at Newark, Ohio, June 17-19; **Connecticut State Association,** George F. Klopfer, 30 East Pearl St., New Haven, Conn., Convention at Norwich, Conn., June 25-26; **Wisconsin State Association,** R. L. Scott, Eau Claire, Wis. Convention at Milwaukee, Aug. 3-6; **Minnesota State Association,** C. A. Nelson, 800 22nd Ave., N. E. Minneapolis, Minn. Convention at Rochester, Minn., Aug. 4-6; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

**New York State Association.** Wilmer T. Meinzer, 3626-215 Place, Bayside, Long Island, N. Y. Postponed from June 11 to 12, at Troy, N. Y., to Sept. 12-13 at Atlantic City, N. J.

**Universal Craftsmen Council of Engineers.** 24th convention and exhibit Milwaukee Auditorium, Milwaukee, Aug. 3-7.

## Trade Catalogs

**Direct Acting Time Limit Attachments** — The Roller-Smith Co., 233 Broadway, New York City. Supplement to Bulletin No. 530, describes attachments for standard type circuit breakers. One illustration and price list of these attachments with an accompanying description. The attachments are simple, sturdy and practically "fool proof."

**Valves, Regulators, and Other Steam Specialties.**—Mueller Steam Specialty Co., manufacturer of steam, water, air, gas, and oil engineering and plumbing specialties, 502 West 126th St., New York City. New catalog No. 22 is now ready for distribution. It describes with illustrations the company's high-grade line of specialties, which includes pressure reducing and regulating valves strainers, boiler controls, steam traps, back-pressure and vacuum regulators, excessive-pressure relief valves, float valves, quick-opening balance valves, pump governors, air traps, and liquid-level controllers.

**Pumps** — The Goulds Manufacturing Co., Seneca Falls, N. Y. A folder bulletin describing and carefully illustrating recent pump developments of this company. Open impeller centrifugal pumps; high efficiency multi-stage centrifugal pumps; automatic-oiling pumps; small centrifugal pumps, unit-engine driven; automatic sump pumps, and ice water circulating pumps are considered in some detail as to design and operation.

## Fuel Prices

### COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

| **Bituminous** Net Tons | Market Quoting | June 7 1926 |
|---|---|---|
| Pool 1 | New York | $2.50@$2.75 |
| Smokeless | Boston | 1.76 |
| Clearfield | Boston | 1.65@ 1.95 |
| Somerset | Boston | 1.75@ 2.10 |
| Kanawha | Columbus | 1.40@ 1.75 |
| Hocking | Columbus | 1.40@ 1.70 |
| Pittsburgh | Pittsburgh | 1.75@ 1.90 |
| Pittsburgh gas slack | Pittsburgh | 1.35@ 1.40 |
| Franklin, Ill. | Chicago | 2.25 |
| Central, Ill. | Chicago | 2.00@ 2.15 |
| Ind. 4th Vein | Chicago | 2.10@ 2.25 |
| West Ky. | Louisville | 1.00@ 1.40 |
| S. E. Ky. | Louisville | 1.10@ 1.25 |
| Big Seam | Birmingham | 1.75@ 2.00 |
| **Anthracite** Gross Tons | | |
| Buckwheat No. 1. | New York | 1.75@ 3.50 |
| Buckwheat No. 1. | Philadelphia | 2.15@ 2.75 |
| Birdseye | New York | 1.30@ 2.00 |

### FUEL OIL

**New York**—June 10, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6½c. per gal. f.o.b. Bayonne, N. J.

**St. Louis**—June 1, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10 per bbl.; 26@28 deg., $2.15 per bbl.; 28@30 deg., $2.20 per bbl.; 30@32 deg., $2.25 per bbl.; 32@36 deg., gas oil, 5.5c. per gal.; 38@40 deg., 6¼c. per gal.

**Pittsburgh**—June, 1 f.o.b. local refinery; 30@34 deg., fuel oil, 6½c. per gal.; 36@40 deg., fuel oil, 7¼c. per gal.

**Dallas**—June 5, f.o.b. local refinery 26@30 deg., $1.70 per bbl.

**Philadelphia**—June 9, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.93@$1.99; 13@19 deg., $1.81 per bbl.

**Cincinnati** — June 8, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

**Chicago**—June 7, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30@$1.35 per bbl.; 26@30 deg., $1.40; 30@32 deg., $1.60@$1.65.

**Boston**—June 8, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.43c. per gal.; 28@32 deg., 5⅜c. per gal.

# New Plant Construction

**Calif., Pasadena** — City, B. F. Delanty, Mgr., plans the installation of a 15,000 kw. additional unit to generating equipment for light and power plant. Estimated cost $750,000.

**Calif., Riverside**—Riverside County will receive bids until July 6 for the construction of a sanitarium including boiler and laundry plant, etc. Estimated cost $150,000. G. S. Wilson, 646 West 9th St., is architect.

**Calif., San Francisco**—City, L. S. Leavy, Purch. Agt., will receive bids until June 21, for a turbine pump and motor.

**Calif., Vallejo**—City, A. Edgcumbe, Clk., plans the installation of an automatic pump to increase water supply in Capitol St. Hill Dist. T. D. Kilkenny, is engineer.

**Conn., New Britain**—City plans the construction of a reservoir and extensions to dam including electric pumping equipment, etc. Estimated cost $2,500,000. J. Williams, City Hall, is engineer.

**D. C., Washington**—City plans improvements to power plant for Home for Aged and Infirm. Estimated cost $14,000.

**Ga., Cedartown**—Goodyear Tire & Rubber Co., East Market St., Akron, O., is having plans prepared for the construction of a 2,000 hp. power plant including equipment here. Estimated cost $300,000. Lockwood, Greene & Co., Healy Bldg., Atlanta, Ga., are engineers.

**Ill., Chicago**—Commonwealth Edison Co., 72 Adams St., awarded contract for the construction of the second section of Crawford Ave. station, including boiler room, turbine room, transformer house, intake crib house, third section of switch house, etc. to Bates & Rogers Construction Co., 37 West Van Buren St. Estimated cost $2,000,000.

**Ill., Glencoe**—City is having plans prepared for the construction of a pumping station and filter plant, 30,000,000 gal. daily capacity. Estimated cost $300,000. Alvord, Burdick & Howson, 6 South Dearborn St., Chicago, Ill., are engineers.

**Kan., Kansas City**—City is having plans prepared for the construction of a new boiler plant in connection with water and light plant, first unit for large water pumping and electric power station, ultimate capacity 100,000 kw. Equipment includes 1,500 hp. boilers, economizers, multiple effect evaporators, steam turbine driven pumps, synchronous motor driven pumps, etc. Initial cost $1,200,000. Ultimate total cost $7,000,000. A. L. Mullergren, Bd. of Trade Bldg., Kansas City, Mo., is engineer.

**Ky., Louisville**—Louisville Water Co., 435 South 3rd St., will soon receive bids for a 40,000,000 g.p.d. turbo centrifugal pump. Alvord, Burdick & Howson, 6 Dearborn St., Chicago, Ill., are engineers.

**La., Shrewsbury** — Shrewsbury Ice & Produce Co., plans the construction of a 30 ton ice plant at Shrewsbury Road and Kenner Air Line to increase the capacity to 60 ton.

**Mass., East Boston** (Boston P. O.)—Dept. of Public Works, Boston, plans the construction of a pumping station on Porter St., here. Estimated cost $600,000.

**Mass., Lynn**—Commission of Ways & Drainage, is receiving bids for the construction of a pumping station, etc. Estimated cost $200,000. M. Knowles, 507 Westinghouse Bldg., is architect and engineer.

**Mass., New Bedford** — Pocahontas Fuel Co. Inc., awarded contract for the construction of a boiler house to W. Young, Spring St., Fairhaven, Conn. Estimated cost $40,000.

**Mich., Detroit**—C. N. Agree, 1133 Book Bldg., Archt., is receiving bids for the construction of an 8 story apartment including steam heating system on Third St., for J. Berman, 1317 Dime Bank Bldg. Estimated cost $850,000.

**Mich., Detroit** — Dean & Sherk, 3220 Bellevue Ave., is having plans prepared for the construction of a factory including boiler house, on Lawrence Ave. Rasemin & Freier, 520 Murphy Bldg., are architects.

**Mich., Melvindale** (Dearborn P. O.)—Village, G. W. Foster, Clk., will soon award contract for the construction of a pumping station including a 10,000 g.p.m. motor driven centrifugal pump. G. Jerome, 1331 Majestic Bldg., Detroit, is engineer.

**Mo., St. Louis**—City, J. Pritchard, Dir., City Hall, will soon award contract for foundations and substructure for power plant at Howard's Bend Waterworks.

**Neb., Hastings**—City, A. T. Bratton, Clk., will receive bids until June 23, for the construction of a sewage disposal plant and pumping station including electrical driven centrifugal pump and motor, etc. Estimated cost $25,000.

**Neb., Mitchell** — Dept. of the Interior, Bureau of Reclamation, will receive bids until July 12, for the construction of a plate steel penstock, surge tank, etc., the installation of a 3,400 hp. vertical hydraulic turbine, generator, transformers, switchboard, etc. at Guernsey power plant, North Platte project, Nebraska-Wyoming.

**N. H., Rochester**—Rochester Realty Co., awarded contract for the construction of a 3 story apartment, office and stores building including power plant at Hanson, Wakefield and Autumn Sts., to S. Belanger & Son., 308 Main St., Nashua.

**N. Y., Brooklyn**—W. Kraslow, c/o Shampan & Shampan, 188 Montague St., Archts., will build two apartment buildings on Ft. Hamilton Parkway by day labor. Total estimated cost $2,800,000.

**N. Y., Brooklyn** — St. John's Hospital, Atlantic Ave., awarded contract for the construction of a 5 story hospital to William Kennedy Construction Co., 215 Montague St. Estimated cost $1,500,000.

**N. Y., Brooklyn**—Sherover Construction Corp., c/o W. J. Hohauser, 1400 Broadway, New York, Archt., will build a 15 story hotel at Ashland Pl. and Lafayette Ave., here. Estimated cost $2,000,000. Work will be done by separate contract under supervision of architect.

**N. Y., Long Beach**—W. H. Reynolds, Lexington Ave. and 43rd St., awarded contract for the construction of a hotel to United Fireproofing Co., 8 West 40th St. Estimated cost $2,500,000.

**N. Y., New York** — Brooklyn Bridge Freezing & Cold Storage Co., 4 Vandewater St., had plans prepared for the construction of an addition to refrigeration plant, Estimated cost $125,000. Private plans.

**N. Y., New York** — N. Minskoff, 2382 Grand Concourse, will build a hotel at 234 West 40th St. Estimated cost $2,000,000. H. Feldman, 516 Fifth Ave., is architect. Work will be done by separate contract, under supervision of owner.

**N. Y., New York**—Rose Marie Holding Co., c/o H. J. Kraft, 1650 Broadway, Archt., is having plans prepared for the construction of a 13 story theatre and office building at 211 West 53rd St. Estimated cost $750,000.

**N. Y., New York** — Zimforf Realty Co., c/o G. & E. Blum, 505 5th Ave., Archts., is having plans prepared for the construction of a 16 story office building at 257 West 38th St. Estimated cost $500,000.

**N. Y., Northport**—U. S. Veterans Bureau, Arlington Bldg., Washington, D. C., will receive bids until July 27, for the construction of various buildings including boiler house, pump houses, refrigeration plant, etc. for U. S. Veterans Hospital here.

**O., Delaware** — City will soon receive bids for the construction of a sewage treatment plant including pumping station, etc. G. B. Gascoigne, Leader-News Bldg., Cleveland, is engineer.

**Pa., Abington** — Bd. of Education, awarded contract for the construction of a power house and gymnasium to Stahl & Walton, Willow Grove. $29,698.

**Tex., Brownsville** — Bd. of Education awarded contract for the construction of a power plant to New & Milton. $21,890.

**Tex., Dallas** — Home of Our Lady of Charity is receiving bids for the construction of a home building including power plant, etc., at Ft. Worth Pike and Wheatland Rd. Estimated cost $150,000. J. E. Overbeck, Wilson Bldg., is architect.

**Tex., Dallas**—Oak Cliff Apartment Corp., J. B. Rucker, 1813 Main St., awarded contract for the construction of a 10 story apartment on Colorado St. to Bellow-Maclay Co., Kirby Bldg. Estimated cost $650,000. Owner will take bids for steam heating equipment, low pressure boiler and fuel oil burners, etc.

**Tex., Muleshoe**—City plans an election to vote $40,000 bonds for improvements to waterworks including pumping equipment, tank on tower, etc. Montgomery & Ward, 545 Harvey-Snider Bldg., Wichita Falls, are engineers.

**Tex., Nordheim** — City will receive bids until June 28 for improvements to waterworks including air compressor and motor, one 125 g.p.m. service direct connected to motor, 50,000 gal. tank, etc. Estimated cost $40,000. Terrell Bartlett, Engrs., Calcasieu Bldg., San Antonio, are engineers.

**Tex., Red Oak**—Waxahachie Ice Works, Waxahachie, awarded contract for the construction of an ice and cold storage plant here to Ramsey Bro., Waxahachie, $22,000. Owner will purchase automatic refrigeration equipment, to cost $10,000.

**Tex., San Antonio** — San Antonio Ice Rink Co., City National Bank Bldg., plans the construction of an addition to ice skating rink including a 12 ton ice plant, etc. Estimated cost $40,000. G. Willis, Builders Exchange Bldg., is architect.

**Tex., Sequin**—City, A. P. Stautzenberger, is having preliminary plans prepared for improvements to light plant to increase the capacity. Estimated cost $15,000. Dynamos, engine, etc., will be required.

**Tex., Yoakum**—City, W. S. Winfree, City Mgr., plans an election soon to vote $50,000 bonds for improvements and extensions to water and light plant including pumping equipment, engine, mains, etc.

**Va., Louisa**—City plans the construction of a waterworks system including two 100 g.p.m. electrically operated pumps, 75,000 gal. tank on 100 ft. tower, etc. Estimated cost $32,000. J. B. McCrary Engineering Corp., Citizens & Savings Bank Bldg., Atlanta, Ga., is engineer.

**Wis., Milwaukee**—Dept. of Public Works awarded contract for foundation, etc., for rebuilding pumping station to Siderits Construction Co., 1591 2nd St. $60,700. Total estimated cost $400,000.

**Ont., Fort William**—Hydro Electric Power Commission, 190 University Ave., Toronto, awarded contract for the construction of a power substation, here, to Macaw & Mac Donald, Winnipeg, Man. Estimated cost $42,800.

**Ont., Hamilton** — Dominion Power & Transportation Co., King St., plans the construction of addition to power station. Estimated cost $50,000. Work will be done by owner's forces.

**Ont., Toronto**—City, T. Foster, City Hall, Mayor, will receive bids until June 29 for an air compressor mounted on Ford truck.

**Ont., Waterford**—Michigan Central R.R., Passenger Terminal Sta., Detroit, Mich., is having plans prepared for improvements to coal handling plant here. Estimated cost $20,000. J. F. Deimling is chief engineer.

**Ont., Windsor**—Watt & Blackwell, Bank of Toronto Bldg., London, Archts., are preparing plans for the construction of a 15 story office building, including steam heating system, etc., here. Owner's name withheld.

**Que., Ste. Anne de Beaupre**—Ste. Anne Power & Paper Co., J. T. Donohue, Pres., Murray Bay, will soon receive bids for the construction of a paper mill, 250 ton daily capacity, and power plant. Estimated cost approximately $5,000,000.

**Australia, Melbourne**—Victorian Government Railways will receive bids until July 26 for one alternating current power interlocking machine.

**N. Z., Wellington**—New Zealand Government Railways will receive bids until Nov. 2 for two turbines and generators complete with spares and tools, etc.

**Panama, Coco Solo**—Bureau of Yards & Docks, Navy Dept., Washington, D. C., L. E. Gregory, Ch. of Bureau, plans the construction of an ice and refrigeration plant including motor-driven rotary and centrifugal pumps, motors for ammonia compressors, ammonia condenser and brine cooler, 15 kva. transformers, refrigeration and ice-making equipment, etc., at Naval Submarine Base here.